

Congestion Pricing Response

Study for Potential Implementation in the Metropolitan Atlanta Area



Produced for
Prepared by

**Georgia Department of Transportation
Center for Quality Growth and Regional Development
& School of Civil and Environmental Engineering
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Executive Summary

Traffic congestion is an increasing burden on American cities. Congested highways delay truck transport and commuters, causing economic and social losses to local businesses and residents and making the area as a whole less attractive to potential residents, investors and visitors. Drivers suffer increased stress and the resulting negative health effects. Long delays in car travel leads to greater amounts of pollutants being emitted into the atmosphere. As a result, one of the foremost challenges confronting towns, cities, regions and transportation providers is the reduction of congestion. Perhaps more importantly, the increasing cost of oil and our current dependence on it make even clearer the need for the introduction of greater efficiency, better management, more sustainable practices, and differential pricing in transportation system planning. There is an even greater expectation that congestion pricing will be a new source of funds to maintain existing and construct new infrastructure.

One strategy that has been introduced in the last several decades to address these concerns is “congestion pricing” or “value pricing.” In short, congestion pricing is the practice of charging drivers to use a specific lane or enter a designated area, such as central London. The idea is to reduce demand, and thus the number of cars competing for space on the road, by making more explicit the costs of adding an additional driver to the lane or area. A refinement of this strategy is to vary the price to reflect demand—in many cases, the price is higher during peak travel periods and lower at other times of the day. The result is freer-flowing travel for those drivers willing to pay the toll.

The key objective of this project was to undertake a comprehensive evaluation of public perceptions and acceptability of potential congestion-pricing implementation and deployment strategies for the metropolitan Atlanta area, in order to help guide GDOT in the siting, evaluation, and implementation of future pricing strategies. The project included consideration of new technologies to be used in implementing congestion-pricing schemes, as well as potential consumer objections to congestion pricing and a summary of the most significant inputs to models or efforts to forecast consumer responses to pricing programs. The research effort will provide a comprehensive examination of public perceptions and preferences in regard to the suitability of potential pricing applications in metropolitan Atlanta. The project results include recommendations of strategies to implement congestion pricing, as well as results from an emissions modeling framework and congestion pricing analysis.

To accomplish this objective, there were five tasks involved in this project:

- I. **Literature Review**— Conduct a review of existing literature related to public acceptance of previous congestion-pricing programs around the US, particularly focusing on: the I-10 Katy Freeway in Texas; the express lanes on I-15 near San Diego, California; State Route 91 near

- Riverside, California; the MNPASS program in the greater Minneapolis area, Minnesota; and the E-470, a limited-access toll highway in Denver, Colorado.
- II. **Expert Panel and Survey**– Conduct a survey of transportation professionals who have implemented congestion pricing projects or programs. This involved telephone calls with email follow-ups to collect information from states and regions that have studied and/or implemented congestion-pricing strategies. In addition, a group of eight experts (practitioners and implementers) came to Atlanta for two days to solicit their advice and experience in implementing value pricing initiatives.
 - III. **Demographic/Travel Profiles**– Create a socio-demographic profile of a corridor-specific sub-area in the greater metropolitan Atlanta area, as identified by GDOT and the project investigators [I-85 North corridor].
 - IV. **Focus Groups**– A series of focus groups were assembled to identify and measure the attitudes, perceptions, preferences and general response to a variety of congestion pricing programs and to specific examples of pricing projects. The focus-group process included an examination of different pricing technologies, toll collection methods, financing and pricing preferences (willingness to pay), and expectations and benefits associated with pricing programs.
 - V. **Emissions Modeling Assessment Framework**– The team developed an emissions modeling assessment framework and congestion pricing monitoring plan that can be implemented by GDOT and ARC in projecting the emission impacts of congestion pricing and value pricing of transportation projects and assessing actual impacts over time.

This executive summary provides a brief overview of the findings of each of the tasks listed above.

Section I: Literature Review

The literature review focused on new congestion-pricing technologies, general literature as to public acceptance of congestion pricing, the case studies of congestion-pricing programs previously implemented in the United States, and examples of congestion pricing outside the United States.

Congestion Pricing Technologies

New technologies now make it considerably easier to establish and enforce a congestion-pricing mechanism, whether the facility is limited to one lane or established as a cordon. The most widely-used new technologies include electronic toll collection via transponders located in individual cars.

Technologies, such as license-plate reading, automatic vehicle occupancy detection, and enforcement gantry lights, are also being developed to assist in enforcement. Such technologies allow for the

separation of a congestion-priced lane's users into those who do not have to pay the toll (e.g. a vehicle with two or three people inside) and those who do.

Audiences for electronic toll collection and transponder use have often responded favorably and adapted to using the new technology. However, there may be privacy concerns with some of the enforcement technology; users may react negatively to having their license plate read or their picture taken by a digital camera trying to determine occupancy.

Public Acceptance

Congestion pricing is still relatively new in the United States, and in some past cases has proven politically unpopular. While there is some evidence that American audiences are becoming slightly more comfortable with the idea of congestion pricing, the idea has not yet been matter-of-factly accepted. Familiarity seems to lead to more positive responses: people who have used a congestion-pricing facility or a toll lane before seem to react more positively to the idea of a congestion-pricing facility than do those who have not. But potential users may react negatively if they believe that a "free" facility is being taken away from them. Turning an HOV (high-occupancy vehicle) lane into an HOT (high-occupancy toll) lane may be more acceptable to the majority of users, but it may provoke opposition from existing HOV users. Users may also cite equity as a concern, fearing that a congestion-free drive will be a privilege limited only to those who can afford it. All of these things can lead to difficulty in generating political support for projects.

There are certain things a public agency can do to mitigate these concerns. First, especially if this is the first proposed congestion-pricing facility in a region, prepare a detailed and comprehensive outreach program. Keep potential users informed as to the features and predicted consequences of the facility, and be willing to adjust the proposal based on their concerns. Second, anticipate heightened scrutiny in some areas, such as the potential equity issues and the planned destination of the resulting revenue. Finally, be able to explain, clearly and memorably, that a congestion-pricing facility will bring benefits to the surrounding area; be able to say what those benefits might be, and why they are worth incurring the costs of a new project.

Case Studies

To explore congestion-pricing experiences in the United States, five facilities that have applied different implementation approaches and experienced varying degrees of public acceptance, have been selected for review. The oldest, State Route 91 (SR-91) in Orange County, California, which was opened in 1995, has relieved congestion in a high-trafficked area but came under public opposition as a result of the way the public-private financing and ownership of the facility was handled. Both the Houston QuickRide facility and the facility on Interstate 25 outside Denver, Colorado, were designed to take advantage of excess capacity on existing HOV lanes. The Express Lanes on Interstate 15 outside San Diego were

originally conceived to raise money for transit, rather than to relieve congestion. The MnPASS facility to the west of Minneapolis/St. Paul has relieved congestion for suburban commuters into the city. It is clear that there is no set formula for a congestion-pricing facility. However, we can note some similarities between the five cases. All five have barrier-separated sections; four have reversible sections. Four of the five are able to balance HOVs and SOVs in the same lane; while enforcement has been a difficulty, it should be recognized that a congestion-priced lane can accommodate both carpoolers and single drivers. We can tentatively conclude that (with the exception of SR-91, which had the additional variable of a prominent public-private partnership coming under fire) all show a trend of consumer acceptance of the congestion-priced facility rising after it opened. This is true whether or not SOVs (single-occupancy vehicles) have been allowed to use the facility. Thus, it may be that the most difficult obstacles for a congestion-pricing project are faced before implementation begins.

Other Strategies

Other congestion-pricing projects are currently being considered in cities both inside and outside the United States. London, Singapore, and Trondheim, Norway have cordon-pricing schemes to price access to the central city. The 38-mile-long, non-barrier-separated HOT facility in Salt Lake City is the most recent and the longest addition to the list of U.S. HOT lanes. Both the northeast United States and Toronto have portions of toll lanes with variable pricing and transponders in use.

In contrast to the five case studies, the congestion-pricing projects in this section show a greater variety of congestion-pricing strategies, including the use of cordons, variable tolls, and monthly vehicle tags, and take different approaches to technology and enforcement. Together, they demonstrate that while congestion pricing remains a politically sensitive issue, there are now more options than ever for putting together a congestion-pricing project.

Section II: Expert Panel and Survey

To enhance the information gathered from the literature review and case study sections of this project, a survey of transportation professionals who have implemented congestion pricing projects or programs was conducted. This task involved two parts: an intensive, two-day expert panel session, and telephone interviews with persons that have been involved at different levels of congestion pricing projects around the country. The goal of this phase of the project was to gather information on public responses to congestion pricing, techniques and policies, obstacles to implementing a congestion-pricing program, and the effects, if any, of congestion pricing on land use.

These tasks facilitated the collection of information from states and regions that have studied and/or implemented congestion pricing strategies. For the first of these tasks, a group of five experts was

brought to Atlanta for two days. During the panel sessions, the experts were asked to describe their experience with implementing congestion pricing in their region. Then, the experts were asked to provide practical advice as to how to implement value pricing initiatives such as congestion pricing in our region. These experts were public officials and transportation experts who have on-the-ground experience with implementing the congestion-pricing schemes and related technologies featured in the five case studies in the literature review chapter of this report.

Panel attendees included Mark Burris (Department of Civil Engineering, Texas A&M, representing Houston QuickRide, I-10, and US 290), Adeel Lari (Hubert H. Humphrey Institute of Public Affairs, University of Minnesota, representing MnPASS, I-394), Ellen Lee (Orange County Transportation Authority [OCTA], representing SR-91 express lanes), Stacey Stegman (Colorado DOT, representing I-25/US-36), and Heather Werdick (San Diego Association of Governments [SANDAG], representing I-15 express lanes).

Each of these topic areas was the focus of a separate session of the expert panel. The following section provides a summary of the expert panel discussions by project. These discussions resulted in the following general operations recommendations, as well as more specific recommendations that are covered in the full chapter.

- Implement congestion pricing
 - The panel members all indicated that their respective pricing systems are working well and are effective in reducing traffic congestion (although the Houston systems are really considered small scale operations at present)
- Don't worry about whether the facility is making money
 - Keep in mind that revenues from HOT and toll systems "are a drop in the bucket" with respect to the overall costs of constructing a corridor
 - The revenue focus in most areas is on covering marginal costs
 - Most regions do not care whether any excess funds are generated because the goal is to reduce congestion at a cost significantly lower than building new capacity
- Incorporate a monthly fee for participating in a priced lane system
 - The fee has been found to be a reasonable approach to raising general operating revenues enough to pay for the administrative overhead of operations (though the revenues are generally small)
- Require that all vehicles using the HOT or toll facility be equipped with transponders
 - A variety of transponder technologies are available for deployment and all can be implemented at reasonable cost
 - Colorado is even requiring the exempt clean vehicles to be transponder equipped so that impacts can be tracked

- Consider the use of new, less expensive, battery-less paper tag transponder technologies
 - However, Houston has indicated that even though they are switching to the lower cost paper tags, the region is looking forward to deploying smart cards to fully integrated parking, transit, and HOT lane payment technologies
- Consider moving directly to smart card technologies to fully integrate payment parking, transit, and tolling systems throughout the region
 - If economically feasible, the region can skip deployment of the battery-less technologies and leap frog ahead of other regions
- Consider using higher-end interactive transponder systems, such as the system deployed by MnPASS
 - The transponder system deployed by MnPASS allow a write function to the RFID and is preferable from a data collection and enforcement standpoint (recommended by MnPASS)
- Ensure that technologies are interoperable throughout the state
 - Consider ensuring that technologies are interoperable throughout the greater southeastern region
- Rather than simply adopting a transponder technology already deployed elsewhere, perform a full 20-year life-cycle cost analysis of hardware tradeoffs before selecting a technology
 - Economic analyses should include the cost of transponder replacement, if battery-powered RFID technology is deployed. The Houston RFID tags are no longer functional, due to the age of the battery systems, which must be refreshed every five years
- Develop a complete micro-simulation model for each pricing corridor, in its entirety
 - Use of a calibrated simulation model is highly recommended for: evaluating alternative designs and predicting system performance response to operational changes
 - More importantly, simulation modeling results and graphic presentations are needed for use in public meetings in to describe system performance and benefits
- Conduct local traffic impact studies
 - Traffic impact studies should be a major element of the project to assure local residents that the system will not impact local traffic at the endpoints
- Use a simulation model to assess potential impacts that each priced facility will have on the traffic volumes of non-priced connecting freeways
- Ensure that subsequent system improvements on parallel facilities do not affect the demand for and revenues from HOT facilities after they are implemented
 - In the case of I-85, implementation of a BRT on Buford Highway could potentially affect I-85 HOT revenues, so both projects should be analyzed concurrently

- Ensure that there is sufficient monitoring in place to assess the benefits of the implemented systems (providing data to support the implementation of new facilities)
 - ATMS machine vision system should monitor before and after traffic volumes, densities, and speeds to document congestion reduction benefits
 - Longitudinal household surveys should be conducted of participants (tollway users, general purpose lane users, express bus riders, and telecommuters) before and after implementation
 - Traffic safety studies should examine before and after crash rates
- Perform an engineering operations review of the MnPASS system

Atlanta design and operations engineers should review how the MnPASS system employs ramp meters within the MnPASS system and determine whether the same linkages should be developed in the Atlanta region.

Section III: Demographic/Travel Profiles

The project included gathering demographic and travel data by capturing license-plate information on major Atlanta highways. In addition to providing a set of “focus” blockgroups for use in targeting potential Commute Atlanta congestion-pricing study participants, the license plate data collected from overpasses provided direct insight on rush hour highway commuters at an unprecedented scale. Using a GIS environment, typical highway commutersheds and associated census data observations were generated. This allowed the study group to come to some conclusions about the demographics and travel patterns of potential users of a congestion-pricing program.

In general, based upon census data analysis and observation frequency, the observed morning rush hour highway commuters were less likely to carpool, take public transportation, or utilize other non-SOV modes than the average resident of the same blockgroup. They were more likely to work at home and had incomes that were on average 15% higher. The longer travel times and high incomes observed in the study indicate that people may be willing to travel further for more prosperous job opportunities. However, it is also possible that multi-income households yield compromises in household location decisions, resulting in longer commutes for one or both workers.

When a highway at rush hour is the route of choice, environmental equity considerations can arise due to the effects of congestion on air quality in the immediate surrounding areas. These externalities can be at least partially mitigated through the use of toll or other managed lanes during congested periods, which would encourage faster travel speeds and thus decrease the vehicle-based emissions of most primary pollutants. Since rush-hour commuters have a greater household income level than the general populace,

imposing a fee for usage of particular high-capacity roads may amount to progressive taxation, potentially dampening some concerns about the effects of managed lanes on vertical (income) equity. The combination of higher incomes and longer commute times may lead to an increased willingness-to-pay for managed lane facilities with guaranteed travel time savings.

Section IV: Focus Groups

Nineteen focus groups were assembled to identify and measure the attitudes, perceptions, preferences and general response to a variety of congestion pricing programs and to specific examples of pricing projects in the Atlanta area. This included an examination of different pricing technologies, toll collection methods, financing and pricing preferences (willingness to pay), and expectations and benefits associated with pricing programs. In addition, the focus group participants were evaluated as to their current familiarity with congestion-pricing technologies and their feelings thereon. Special consideration was given to potential public objections to congestion pricing—for example, if users were to consider congestion pricing “double taxation” or regard toll lanes as “Lexus lanes” enjoyed only by the wealthy.

The groups consisted of 8-12 participants and one facilitator for a 90-minute discussion and were conducted at a professional facility. Representatives of the Georgia Tech team observed the groups from behind a one-way mirror and utilized audio and visual recording. Focus group participants were given information on three types of managed lanes (high occupancy toll [HOT], variable priced high occupancy toll [VHOT], and express lanes) and were presented with several questions including what they like or do not like about the types of managed lanes and under which conditions they would be likely to use the managed lanes.

Preliminary analysis of the focus groups responses suggests that public attitudes towards congestion pricing programs in Metropolitan Atlanta are similar to those seen in other areas of the United States. Respondents were generally open to listening to solutions that may reduce congestion. There was a general distrust of the ability of governmental agencies to provide guaranteed speeds or to properly manage the facilities or the proceeds from the tolls. There were also concerns about lanes being “taken away” from general use and congestion pricing amounting to “double-dipping” by the government since fuel taxes are already being used for road-building. Additionally, concerns about the fairness of congestion pricing programs were articulated.

A majority of participants indicated a willingness to use a managed-lane facility, with HOT lanes being the most likely to be used. Willingness to use was higher among those participants who were familiar with existing managed-lane facilities and technologies, such as the HOV lanes or the Georgia-400 CruiseCard program. While the participants generally believed that managed lanes were generally fair and equitable,

there were some concerns raised about those who do not have the ability or flexibility to adjust commute times and low-income users.

When asked what attributes they liked about HOT lanes, respondents commented on guaranteed speeds, the ability of SOV to pay to use the facility, and the overall reduction of congestion on both the HOT and general purpose (GP) lanes. Dislikes of the HOT lane concept included a lack of trust that the guaranteed speed will be provided, concerns about accidents in the HOT lane, worries about the toll being in effect double taxation, and concerns about construction costs.

When asked what attributes they liked about VHOT lanes, respondents liked the market-driven nature of the concept, the possibilities for higher congestion relief, the increased flexibility, and the possibility for discounted toll prices at low congestion or off-peak hours. The dislikes of the VHOT concept included concerns about the complexity of implementing and utilizing a variable pricing scheme, difficulties that variation in tolls would have on [personal] travel expense budgeting, the potential for the tolls to be regressive (lower income drivers may not have the flexibility to avoid high toll times), and a distrust in the government's ability to accurately verify vehicle speeds.

With regards to express lanes, respondents stated that the lanes would be beneficial for drivers with long commutes, increase safety due to a minimization of weaving into and out of the lane, and provide a good alternative for non-commuting vehicles driving from one side of town to the other without the need to stop. The dislikes of express lanes include concerns about the effect of breakdowns or accidents in the lane, the lack of convenience due to the limited number of access and egress point, and the potential confusion during the implementation phase and for out-of-town drivers.

The results from these focus groups contain much valuable information that will lead to a more thorough understanding of public attitudes towards and willingness to accept different congestion pricing facilities.

Section V: Emissions Modeling Assessment Framework

Transportation planners are required to evaluate the potential air quality impacts of major federal transportation projects. Unfortunately, the complicated processes involve the use of multiple models, making impact analyses difficult and time-consuming to perform for local projects. A single tool designed to automate modeling routines would allow policy makers to more readily modify appropriate model input variables for proposed projects would significantly improve the process of undertaking transportation and air quality conformity analysis in non-attainment areas. These same modeling tools could also be used in project-level air quality impact analysis to evaluate the comparative downwind pollutant concentration impacts of project alternatives for environmental impact assessment documents for environmental

assessments. Eventually, automation tools could allow policy analysts to run all required models in background and assess the impacts of a wide variety of infrastructure development on an ongoing basis.

The spatial data components of the modeling tool allows users to specify the transportation link coordinates of the network affected by any proposed transportation project or policy as input to the modeling tool. Traffic volume and related data can be integrated from the regional travel demand model (TDM), any traffic simulation model, or from direct observational measurements. The links for the selected roadway system and their associated link IDs can be pulled from the regional travel demand model or from the CORSIM or VisSim simulation models developed for a freeway or arterial corridor. Subfleet composition data and average speed data by facility type are used in the emission rate lookup and composite emission rate development processes of the MOBILE-Matrix element.

The MOBILE-Matrix component of the modeling tool uses a multi-step process to arrive at a composite emission rate for each roadway link and then calculates mass emissions by pollutant for each modeled transportation link. The MOBILE-Matrix modules are based upon previous work performed by members of the research team (Guensler, et al., 2004). The MOBILE-Matrix emission rate elements of the modeling toolkit begin with the creation of a multi-dimensional database of baseline emission rates for the Atlanta region. Thousands of MOBILE6.2 emission rate modeling runs are employed to develop baseline emission rate matrices. Each modeling run incorporates standardized environmental conditions (temperature, humidity, and average barometric pressure) for winter or summer scenarios of interest, along with standardized input parameters to represent regional inspection and maintenance and fuels programs. The resulting MOBILE-Matrix emission rate matrices are organized by calendar year, summer or winter scenario, facility type, on road vehicle speed, and ambient temperature. Each sub-matrix contains emission rates by vehicle class and model year. With the multi-dimensional matrix complete, composite roadway emission rates for any calendar year, facility type, on road vehicle speed, temperature, summer or winter scenario, vehicle class distribution, and model year distribution are developed through a simple mathematical process. Hence, emission rate changes for any project that affects fleet composition or on road operating conditions can be readily predicted using this modeling tool. Composite emission rates for CO, PM_{2.5}, PM₁₀, NO_x, and HC are multiplied by daily or hourly traffic volumes to predict daily or hourly mass emissions from the facility for mass emissions comparison or emissions budget testing. Coupled with projections of changes in VMT from the travel demand or traffic simulation model, or from direct observation, the net emissions and emissions changes from a facility can be calculated.

Conclusion

The biggest challenges to a congestion-pricing project, in terms of public acceptance, are familiarizing the public with the tolling mechanism and explaining the potential benefits, as opposed to the more evident costs. However, in most cases, public acceptance has increased once the congestion-pricing project has been implemented and shown to function smoothly.

A congestion-pricing project in metropolitan Atlanta would face similar obstacles. There may also be some public resentment based on distrust of state government and the perception that residents are being asked to pay for a previously “free” service. Furthermore, because of Atlanta’s history of racial inequalities, equity questions might be even more politically volatile than they would be in another city. Any congestion-pricing project would need to be carried out with awareness of these issues and a well-structured public information campaign with plenty of opportunities for public input and interaction with decision-makers.

Transportation planners and programmers in the Metropolitan Atlanta area face many of the same issues and public perceptions that have been seen in areas that have successfully implemented congestion pricing facilities throughout the United States. The work done during the planning and implementation stages of these projects will provide valuable guidance as the Metropolitan Atlanta area pursues congestion pricing strategies. Following is a list of preliminary findings that have arisen from this study.

Findings:

- It is important to start ‘messaging’ about the proposed implementation early in the process.
 - One of the most important messages is that the HOT system provides choice for the users: 1) you can choose to pay and use the system, 2) you can choose not to pay and use the existing system, or 3) you can choose to use the improved transit service that is paid for by the system.
 - The user community needs to understand that the implementation of user fees lessens the reliance on gas taxes.
 - Emphasize that managed lanes are not a short-term “band-aid,” but one tool in a long term comprehensive plan.
 - A single consistent message is not critical to the success of HOT lane and toll projects; develop different messages for different stakeholders.
 - HOT lanes are not a major revenue source and are barely able to pay for themselves, so the major focus should be on the fact that the HOT lanes ensure that the revenues being spent on the system are returned directly to the corridor from which they are generated,

- Outreach should also focus on showing the public that the HOT lane is carrying more people/lane/hr than the general purpose lanes. They increase overall capacity.
- Potential negative impacts of road pricing on low-income households has not turned out to be as significant an issue as was originally envisioned in public policy papers:
 - Focus groups and observation data have indicated that although the low-income population uses the toll lanes less frequently than higher income populations, the low-income population benefits significantly from the provision of the toll lanes.
 - Low-income populations are generally in favor of implementing HOT lanes because they have a need to use these lanes for specific types of trips and are willing to pay the costs to save time under certain conditions.
 - None of the HOT systems have implemented any low-income adjustments to tolls as there has been no expressed need for such adjustments; hence, the Atlanta system does not need to provide low-income toll adjustments.
- The transportation agency should not necessarily be the 'face' for HOT or toll project implementation; it is important to ensure that the individuals carrying the project message have clout with the user community
- Finding local champions for the projects is a critical element of success (e.g. elected or appointed local officials at the county or city level)
 - A seminar for local government officials on the benefits of HOT lanes might be a good venue for developing local champions.

The research in this study suggests that community representatives need to be involved early in the process of developing any HOT system. However, in addition to educating influential decision makers, it is also critical that regions implementing pricing strategies conduct public outreach campaigns. Such campaigns can include direct mail contact, interaction with stakeholders, and interaction with the print, radio, and television media.

The research conducted for this project suggests that public acceptance for congestion pricing programs is higher after project implementation than in hypothetical scenarios. The hypothetical scenarios presented to the study focus groups were generally well accepted. It can be expected that using the guidance of previously successful programs around the U.S. that Metropolitan Atlanta transportation planners, programmers, and policy makers can generate public support for congestion pricing initiatives in the Atlanta area.

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Section I: Literature Review



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Congestion Pricing Response

Section I: Literature Review

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Executive Summary

Traffic congestion is an increasing burden for American cities. Clogged, slow-moving freeways and interstate highways can delay truck transport and commuters, causing losses to local businesses and making the area as a whole less attractive to potential economic investors. Drivers suffer increased stress and the resultant negative health effects. Long delays in car travel leads to greater amounts of carbon dioxide and other pollutants being spilled into the atmosphere, increasing air pollution. In short, city and state transportation agencies have a strong interest in reducing congestion.

One strategy that has been introduced in the last several decades is “congestion pricing” or “value pricing.” In short, congestion pricing is the practice of charging drivers to use a specific lane or enter a designated area, such as central London. The idea is to reduce demand, and thus the number of cars competing for space on the road, by making more explicit the costs of adding an additional driver to the lane or area. A refinement of this strategy is to vary the price to reflect demand—in many cases, the price is higher during peak travel periods and lower at other times of the day. The result is freer-flowing travel for those drivers willing to pay the toll.

This literature review explores advances in congestion pricing technologies, public acceptance of congestion pricing, case studies of five facilities, and a review of other strategies. It is intended to support the “Congestion Pricing Response” project currently being conducted by the Georgia Institute of Technology on behalf of the Georgia Department of Transportation (GDOT). The expectation is that this project, when completed, will help guide GDOT in the siting, evaluation, and implementation of future pricing strategies.

Congestion Pricing Technologies

New technologies now make it considerably easier to establish and enforce a congestion-pricing mechanism, whether the facility is limited to one lane or established as a cordon. The most widely-used new technologies include electronic toll collection via transponders located in individual cars. Technologies, such as license-plate reading, automatic vehicle occupancy detection, and enforcement gantry lights, are also being developed to assist in enforcement. Such technologies allow for the separation of a congestion-priced lane’s users into those who do not have to pay the toll (e.g. a vehicle with two or three people inside) and those who do.

Audiences for electronic toll collection and transponder use have often responded favorably and adapted to using the new technology. However, there may be privacy concerns with some of the enforcement technology; users may react negatively to having their license plate read or their picture taken by a digital camera trying to determine occupancy.

Public Acceptance

Congestion pricing is still relatively new in the United States, and in some past cases has proven politically unpopular. While there is some evidence that American audiences are becoming slightly more comfortable with the idea of congestion pricing, the idea has not yet been matter-of-factly accepted. Familiarity seems to lead to more positive responses: people who have used a congestion-priced facility or a toll lane before seem to react more positively to the idea of a congestion-priced facility than do those who have not. But potential users may react negatively if they believe that a “free” facility is being taken away from them. Turning an HOV (high-occupancy vehicle) lane into an HOT (high-occupancy toll) lane may be more acceptable to the majority of users, but it may provoke opposition from existing HOV users. Users may also cite equity as a concern, fearing that a congestion-free drive will be a privilege limited only to those who can afford it. All of these things can lead to difficulty in generating political support for projects.

There are certain things a public agency can do to mitigate these concerns. First, especially if this is the first proposed congestion-pricing facility in a region, prepare a detailed and comprehensive outreach program. Keep potential users informed as to the features and predicted consequences of the facility, and be willing to adjust the proposal based on their concerns. Second, anticipate heightened scrutiny in some areas, such as the potential equity issues and the planned destination of the resulting revenue. Finally, be able to explain, clearly and memorably, that a congestion-pricing facility will bring benefits to the surrounding area; be able to say what those benefits might be, and why they are worth incurring the costs of a new project.

Case Studies

To explore congestion-pricing experiences in the United States, five facilities that have applied different implementation approaches and experienced varying degrees of public acceptance have been selected for review. The oldest, State Route 91 (SR-91) in Orange County, California, which was opened in 1995, has relieved congestion in a high-trafficked area but came under public opposition as a result of the way the public-private financing and ownership of the facility was handled. Both the Houston QuickRide facility and the facility on Interstate 25 outside Denver, Colorado, were designed to take advantage of excess capacity on existing HOV lanes. The Express Lanes on Interstate 15 outside San Diego were originally conceived to raise money for transit, rather than to relieve congestion. The MnPASS facility to the west of Minneapolis/St. Paul has relieved congestion for suburban commuters into the city.

It is clear that there is no set formula for a congestion-pricing facility. However, we can note some similarities between the five cases. All five have barrier-separated sections; four have reversible sections. Four of the five are able to balance HOVs and SOVs in the same lane; while enforcement has been a

difficulty, it should be recognized that a congestion-priced lane can accommodate both carpoolers and single drivers. We can tentatively conclude that (with the exception of SR-91, which had the additional variable of a prominent public-private partnership coming under fire) all show a trend of consumer acceptance of the congestion-priced facility rising after it opened. This is true whether or not SOVs (single-occupancy vehicles) have been allowed to use the facility. Thus, it may be that the most difficult obstacles for a congestion-pricing project are faced before implementation begins.

Other Strategies

Other congestion-pricing projects are currently being considered in cities both inside and outside the United States. London, Singapore, and Trondheim, Norway have cordon-pricing schemes to price access to the central city; New York City is looking to implement a similar scheme for downtown Manhattan. The 38-mile-long, non-barrier separated HOT facility in Salt Lake City is the most recent and the longest addition to the list of U.S. HOT lanes. Both the northeast United States and Toronto have portions of toll lanes with variable pricing and transponders in use.

In contrast to the five case studies, the congestion-pricing projects in this section show a greater variety of congestion-pricing strategies, including the use of cordons, variable tolls, and monthly vehicle tags, and take different approaches to technology and enforcement. Together, they demonstrate that while congestion pricing remains a politically sensitive issue, there are now more options than ever for putting together a congestion-pricing project.

Conclusions

The biggest challenges to a congestion-pricing project, in terms of public acceptance, are familiarizing the public with the tolling mechanism and explaining the potential benefits, as opposed to the more evident costs. However, in most cases, public acceptance has increased once the congestion-pricing project has been implemented and shown to function smoothly.

A congestion-pricing project in metropolitan Atlanta would face similar obstacles. There may also be some public resentment based on distrust of state government and the perception that residents are being asked to pay for a previously “free” service. Furthermore, because of Atlanta’s history of racial inequalities, equity questions might be even more politically volatile than they would be in another city. Any congestion-pricing project would need to be carried out with awareness of these issues and a well-structured public information campaign with plenty of opportunities for public input and interaction with decision-makers.

Glossary

Automatic Vehicle Classification (AVC): when a transponder is used to classify the vehicle from which it is transmitting, usually by weight or number of axles.

Automatic Vehicle Identification (AVI): when electronic tags installed in the vehicle can communicate with roadside readers to identify vehicle ownership.

Congestion pricing: the practice of charging drivers to use a specific lane or enter a designated area. Also called “value pricing.”

Electronic toll collection (ETC): a system that uses vehicle-to-roadside communication technologies to perform an electronic monetary transaction between a vehicle, passing through a toll station, and the toll agency.

Gantry: an structure (such as a sign) mounted on an overhead support under which cars traveling the highway must pass.

High-occupancy toll (HOT): a toll lane in which single-occupancy vehicles must pay but vehicles with two or more persons inside can travel for free.

High-occupancy vehicle (HOV): a passenger vehicle with two or more persons inside.

License-plate recognition (LPR): when cars are identified by their license plates, read via video recording.

Managed lane: a toll lane in which the price of the toll varies with demand for the lane: the toll is higher during peak travel periods.

Mobile enforcement transponder reader (MER): a unit which allows a police officer to read the transponders of passing vehicles, or to travel adjacent to a vehicle in the HOT lane and read the transponder.

Radio frequency identification (RFID): the technology most frequently used in the United States for the communication between an in-vehicle transponder and a receiver. The frequency is usually 900 MHz.

Single-occupancy vehicle (SOV): a passenger vehicle with only one person (the driver) inside.

Super-low-emissions vehicle (SLEV or SULEV): a vehicle which has been found to emit considerably fewer emissions than standard passenger vehicles (in California, the standard is that SLEVs are 90% cleaner than standard vehicles). SLEVs are allowed to use HOV lanes in many states even if occupied by only one person.

Introduction

State and federal departments of transportation are faced with the tasks of not simply increasing access to transportation, but battling congestion, mitigating the negative environmental impacts of personal transport, and maintaining existing infrastructure. Moreover, as America's population grows, infrastructure capacity has become a pressing issue for many cities and regions. Clogged, slow-moving freeways and interstate highways can delay truck transport and commuters, causing losses to local businesses and making the area as a whole less attractive to potential economic investors. Drivers suffer increased stress and the resultant negative health effects. Long delays in car travel leads to greater amounts of carbon dioxide and other pollutants being spilled into the atmosphere, increasing air pollution.

These increasing concerns about congestion and lack of infrastructure capacity have led to greater consideration of congestion pricing than in the past. In this case, congestion pricing refers to the act of making one or more lanes on a given stretch of public road a tolled facility. It is now possible to vary the toll as to increase or reduce demand so that speed in the toll lane (also known as a "managed lane"; see Glossary) can remain at a constant speed relative to the flow of traffic.

Introducing tolled lanes may allow for an increase in the capacity of the remaining lanes and thus a reduction in the overall congestion. Congestion pricing may also reduce congestion by reducing the number of cars on the road. A survey of Dutch car owners suggested that between 6% and 15% of car trips would be adjusted by drivers in response to tolls; of those adjustments, between 91.5% and 98.5% would be to alternatives to cars, such as public transport, non-motorized travel, or not making the trip at all (Ubbels and Verhoef, 2006). A similar study commissioned by the United Kingdom Department for Transport suggested that a charging scheme with 10 different price levels could result in a reduction of congestion of British roads by 46% (Bonsall et al., 2006).

In the United States, the opportunity for congestion pricing has in part come about from the perceived underutilization of existing high-occupancy vehicle (HOV) lanes on interstate highways. These lanes, whose creation was largely funded by federal grants, are meant to be used only by vehicles with one or more passengers in addition to the driver. HOV lanes are often marked separately from other lanes (see Figure 1), and solo drivers can be fined if caught driving in the HOV lanes.

HOV lanes, however, have been perceived as relatively ineffective tools of congestion management. They do not offer sufficient incentive for enough drivers to change their behavior to noticeably reduce congestion, and are often perceived as being underutilized. Moreover, since HOV lanes are only infrequently barrier-separated, enforcement can be difficult, further reducing drivers' incentives to carpool. Toll lanes can be more effective at reducing congestion than HOV lanes because they can be used by

more drivers and because, in the cases of barrier-separated toll lanes, they can be more easily enforced, and can promise better shielding from congestion caused by accidents, than can HOV lanes.

Because congestion pricing is still relatively new in the United States, this literature review will examine both recent technological advances in congestion pricing and what is known about public acceptability of congestion pricing. In addition, it will describe five of the best-known examples of successfully implemented congestion-pricing programs in the United States: the “QuickRide” program on Interstate 10 and US-290 outside Houston; the MnPASS program on Interstate-394 west of Minneapolis-St. Paul; the Express Lanes on Interstate 15 outside San Diego; the high-occupancy toll lanes on State Route 91 in Orange County, California; and the recently implemented toll facility on Interstate 25 outside Denver. This review also includes a brief summary of less typical examples of congestion pricing in the United States and abroad.

This literature review will thus provide an overview of the most recent advances in congestion pricing, and how public audiences have reacted to these advances. It is designed to help transportation planners who might be considering a congestion-pricing program to avoid past mistakes and learn from best practices.

Making Congestion Pricing Feasible: Advances in Technologies

While tolled roads have existed for centuries, variable pricing has only become feasible in the last two decades due to advances in traffic-monitoring technology. Electronic payments further facilitate variable pricing, as users can have money deducted automatically when their car crosses the tolled area. Toll facilities have also begun relying on cameras for vehicle identification, as is the case in London's congestion zone and on Toronto's E-470 tolled highway. The following section discusses the most recent advances in technology that might be useful when designing a congestion-pricing facility.

Electronic Toll Collection

Electronic Toll Collection (ETC) is a technology that allows for electronic payment of highway tolls and is essential to the high-occupancy toll (HOT) concept. ETC systems use vehicle-to-roadside communication technologies to perform an electronic monetary transaction between a vehicle passing through a toll station and the toll agency. ETC allows toll-collection transactions to be performed while vehicles travel at near highway cruising speed. Electronic Toll Collection is becoming a globally accepted method of toll collection, with the help of improvements in ETC technologies. ETC systems have the potential to:

- reduce queues at toll plazas by increasing toll booth service rates;
- save fuel and reduce mobile emissions by reducing or eliminating deceleration, waiting times, and acceleration; and
- reduce toll collection costs.

An ETC system typically includes the following components:

1. Automatic Vehicle Identification (AVI), using radio frequency identification (RFID)
2. Automatic Vehicle Classification (AVC)
3. Video Enforcement Systems (VES), using License Plate Recognition (LPR) and Barcode License Plate Recognition
4. Lane discrimination technology

Automatic Vehicle Identification / Radio Frequency Identification

Automatic Vehicle Identification (AVI) technology enables various ETC applications through its ability to accurately identify a specific vehicle at highway speeds. AVI entails the use of electronic tags installed in the vehicle, which communicate with roadside readers to identify vehicle ownership (Smith and Benko, 2007). As a vehicle passes under a toll-collection gantry (overhead sign assembly), its electronic identification, encoded into a transponder installed in the vehicle (see Figure 1), is read by a gantry-

mounted or roadside device. The vehicle identification is then used to deduct the applicable toll from the customer's preexisting account, or the customer is sent an invoice.

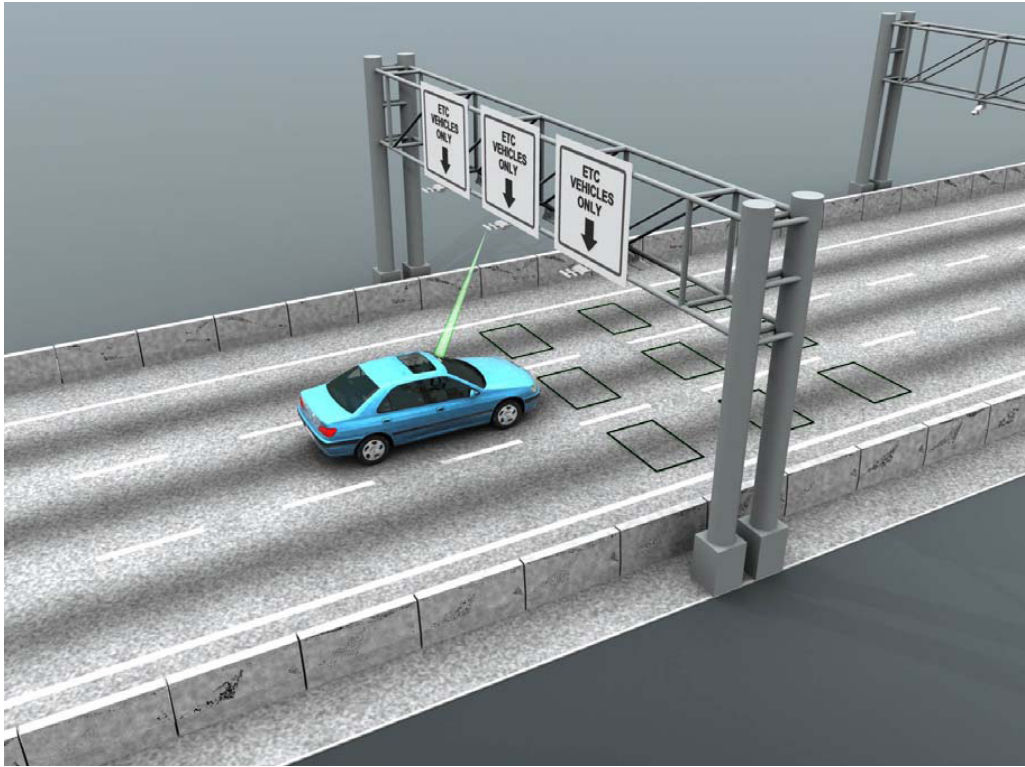
Figure 1: FasTrak Transponder



Source: SANDAG (2003)

In the U.S., the transmission of an identification code between the transponder and a roadside reader is usually handled by a radio frequency identification (RFID) unit operating in the 900 MHz radio frequency band. The driver does not have to stop to pay the tolls, and no tollbooths are required. ETC also determines whether the cars passing are actually enrolled in the program, and can store the information on the vehicle in violation for further collection or enforcement action (IBI Group and Cambridge Systematics, 2006).

Figure 2: Schematic of Automatic Vehicle Identification Process



Source: IBI Group and Cambridge Systematics (2006)

Automatic Vehicle Classification

Traditionally, tolls have been differentiated by vehicle class. Automatic vehicle classification technologies installed in the roadway can determine a vehicle's class by its physical attributes, such as weight, length and number of axles. For the purpose of high-occupancy toll (HOT) lanes, vehicle classification is usually less important. Heavy commercial vehicles other than buses are generally excluded from the HOT lanes. Transponders used for AVI also allow for a quick and easy vehicle classification method. On Electronic Toll Route 407 (Canada), heavy vehicles which have weight over five tons are required to carry a transponder, which is set up to automatically charge a heavy vehicle rate (407 Express Toll Route, 2007). On SR-91 Express Lanes in California, high occupancy vehicles are required to carry a transponder, and use the facility at no charge or at a discounted charge, depending on the time of travel (Orange County Transportation Authority (OCTA)).

Vehicle Enforcement Systems, License Plate Recognition (LPR), and Barcode License Plate Recognition

Toll violators could be monitored by video enforcement systems, which use video imaging and license plate recognition to photograph their license plates in order to identify and fine the vehicle owner. The license plate recognition (LPR) technology allows the deciphering of license plate numbers.

Approximately 30 private companies currently offer LPR systems. When a toll violation is detected, the LPR system is activated to record the offending vehicle's license plate and store it for further transmission to a management center via standard telephone lines, cellular communication, radio transmission or Ethernet. Using automated violation processing, the license plate numbers can be used to automatically access the DMV records and find the owner's name and address. The driver can then be sent a citation by mail, much like a red light running ticket for violators caught on camera. Increasingly, this technology is becoming more reliable, with recognition rates up to 99.5%, even during severe weather conditions (Cothron, Skowronek et al. 2003).

LPR is the primary mode of tolling on Route 407 in Toronto. About 30% of the users have transponders installed. As the driver passes under a gantry, the system detects whether a valid transponder is present. If not, two separate cameras take a picture of the license plate, to ensure accuracy. The digital pictures are reviewed by a computer, and by a human eye in a small percentage of cases. The license plate numbers are linked with the DMV records, and the drivers are sent a "V-Toll" bill in the mail. There is a surcharge for being billed by V-Toll, rather than through using a transponder. In 2005, over 100 million trips were processed with an accuracy rate of 99.9%. (407 Express Toll Route)

Instead of LPR, it is possible to use barcodes printed on the back of vehicles. Barcode license plate recognition has been made possible by high-speed bar code readers, in combination with cameras with pulsed infrared illumination and a very fast shutter speed to capture crisp images at highway speeds. Developed computer software can analyze the video stream at 60 frames per second, and detect if a bar code image is present. If a bar code image is detected, that image can be separated from the video stream and used to automatically identify the vehicle.(Cothron, Skowronek et al. 2003) Currently, LPR is a more widely tested and used technology than barcode recognition. Barcode recognition systems might be most applicable in freight tracking and enforcement.

Lane discrimination technology

Lane discrimination technology is used to ensure that overhead transponder readers only collect signals from the AVI transponders in the appropriate lane. This would be important when a transponder-carrying vehicle is traveling in one of the regular lanes adjacent to a high-occupancy toll lane.

ETC Technology Interoperability

As more and more localities implement electronic tolling, the question of accommodating travelers from another area arises. With V-Tolls, as implemented on Route 407 in Toronto, out-of-state drivers are sent a V-Toll in the mail, thanks to the agreements between Ontario and other Canadian provinces. When the tolling system relies primarily on transponders, the interoperability of technology is an issue. In California, State legislature required that one single technology be used on all toll projects. Now, 79 miles of toll

roads and bridges in California are all using FasTrak® electronic tolling technology. Because all transponders within the state are interoperable, a customer can use the same transponder on toll bridges in Northern California and on toll roads in San Diego. No national electronic tolling standard has been established at this point. FasTrak® transponders cannot be used on East Coast tollways. Instead, E-ZPass™ technology is used in the North Eastern United States. As many older toll authorities consider open-road electronic tolling, creating a national tolling standard could become very important (Leahy 2005).

Other Technologies

In enforcing an HOV or an HOT facility, one of the primary difficulties is that only some of the users of the facility are required to pay a toll (e.g. carpoolers go free, or pay a discounted toll). One of the essential enforcement tasks, therefore, is differentiating between the vehicles that satisfy the occupancy requirements and are not required to pay a toll, and those that have to pay a toll. Various strategies exist in dealing with the differentiation process: separate lanes for HOVs and SOVs as they pass through the tolling station on I-25 in Denver; requiring both SOVs and HOVs to carry transponders, used on SR-91 in Orange County, California; enforcing occupancy requirement manually by patrolling officers, aided by public self-monitoring programs such as HERO, in Houston. This section will cover possible automated occupancy-detection technology and technologies available to assist officer enforcement.

Automated Vehicle Occupancy Detection

Obtaining accurate occupant counts is one of the main hurdles in automating HOT and HOV lane enforcement. Automated vehicle occupancy detection technology remains in the research and testing stage, and no full-scale systems have been implemented as of yet. However, it is important to keep track of technology development, as an automated vehicle occupancy detection system would be ready for implementation in the near future. The two main types of automated vehicle occupancy detection are remote and in-vehicle detection.

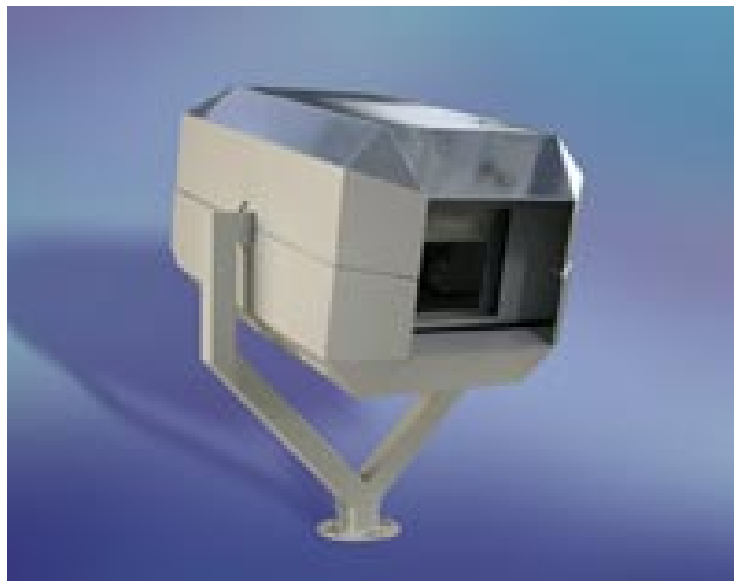
Remote occupancy detection uses systems outside of the vehicle and attempts to determine the number of people in the vehicle through manual or automated analysis of video and infrared images. A typical automated occupancy detection strategy would involve installing at least three cameras with artificial lighting sources: to capture the front windshield view, the side window view, and the rear license plate. A semi-automatic review process can detect when the number of occupants is less than required, electronically saving the images of the vehicle's interior and license plate for later manual confirmation and citation processing.

A semi-automated HOV occupancy enforcement system has been tested on the I-30 contra-flow HOV lane in Dallas, Texas, under the name of HOVER. Transformation Systems, Inc. (Transfo) of Houston,

Texas, collaborated with Computer Recognition Systems, Inc. (CRS), Texas Transportation Institute and other agencies in installing and configuring the HOVER system (Turner 1999). While the system was found to be effective for mailing educational information to suspected violators, the results also showed that actual enforcement would require better quality video cameras, reduced video signal transmission loss, additional camera views and better license plate recognition. There are additional difficulties in capturing images of children in a vehicle, or in dealing with tinted windows (Cothron, Skowronek et al. 2003).

The most successful automated occupancy system to date is the DTECT system, developed in the United Kingdom by Vehicle Occupancy Limited (Vehicle Occupancy Limited, 2007). DTECT illuminates the windshield area with two different wavelengths of infrared light and takes 2 digital infrared pictures of the windscreen at the instant of illumination. The output is a vehicle occupancy count that can be transmitted by an Ethernet link to a remote location within seconds. The complete DTECT system (see Figure 4) is contained within a single housing and mounted on a roadside support or on an overhead gantry. Tests on the A467 HOV lane in Leeds, England claim a 95% success rate in detecting real people and rejecting dummies (Poole 2006). Production is provisionally scheduled for the 4th quarter of 2007 (Vehicle Occupancy Limited, 2007).

Figure 3: Complete DTECT system is contained within a single weather and vandal-proof housing



Source: Vehicle Occupancy Limited (2007)

In-Vehicle Occupancy Monitoring

Due to the problems with automated detection methods because of inherent visibility limitations in the darkness, as well as the difficulty in seeing all of the seats in the vehicles, detecting the occupancy from

within the vehicle and then transferring that information to the monitoring agency could be considered as another potential solution. As of 2006, all new vehicles must have smart air bags, which include occupancy-detection systems in the front seats. This pre-existing technology could be readily adapted to occupancy enforcement if smart airbag sensor data could be transmitted to the gantry systems. The need for police to enforce occupancy in the field could be significantly reduced, once the managed lane users are restricted to vehicles equipped with an OMS. (Schijns, 2005)

There are concerns, however, about on-board OMS use for managed lanes occupancy. These concerns include privacy and civil liberty perceptions, cost of on-board unit to transmit the information, accuracy and reliability (very important if the ticketing of violators would be done by mail), and lack of political and public acceptance (Schijns, 2005)

According to Poole (2005), an in-vehicle approach for determining vehicle occupancy would not be a good enforcement strategy due to high costs and the fact that OMS applies only to the two front seats of the vehicle and would not help on HOV3+ facilities. Instead, he advocates outfitting eligible work carpools and vanpools with a transponder at no charge.

Technologies that Assist Officer Enforcement

Enforcement Gantry Light (I-15 San Diego, MnPASS) Enforcement gantry lights, or beacons, are installed on toll gantries. The light flashes when a vehicle with a valid transponder enters (see Figure 4). This simple technology allows a police officer following a vehicle to make a quick visual check as to whether the vehicle is in good standing.

Figure 4: Enforcement Gantry Light



Source: Halvorson and Buckeye (2006)

Handheld Transponder Reader (MnPASS) The transponder readers allow enforcement officers to follow an SOV through a toll zone and determine if the SOV has a MnPASS account. When the SOV passes through the toll zone, the system will cause the enforcement transponder in the trailing officer's vehicle to issue an audible beep. If the officer does not hear the beep, the vehicle is in violation.

Mobile Enforcement Transponder Reader (MER) (MnPASS). Once installed in an enforcement vehicle, an MER unit allows an officer to read the transponders of passing vehicles, or to travel adjacent to a vehicle in the HOT lane and read the transponder (see Figure 5). The mobile unit provides the officer with the last date and time the transponder was read and the account status (e.g. valid, not valid). This technology can ensure users are not disengaging their vehicle's transponders as they pass under tolling gantries (Halvorson and Buckeye, 2006).

Figure 5: MER Unit



Source: Halvorson and Buckeye (2006)

Consumer Responses to Technologies

While the general public might have mixed views regarding electronic tolling technology, users of existing Express and HOT lane facilities are voting in favor by signing up for accounts and transponders in high numbers. For example, on State Route 91, the oldest Express lane facility in the U.S., additional 5,000 customers signed up for accounts in 2006, and 56% of all customers in 2006 have been users of the facility for seven years or more (Orange County Transportation Authority, 2006).

According to a NuStats report, the MnPASS program users in Minnesota reported a high satisfaction rating of the MnPASS subscription process and usage:

- 83% of MnPASS users were satisfied with the ease of opening a pre-paid MnPASS account.
- 83% of MnPASS users were satisfied with the ease of installing the MnPASS transponder.
- 87% of MnPASS users were satisfied with using a credit card to replenish their account.
- 93% of MnPASS users were satisfied with electronic operations of the system (NuStats 2006).

I-15 commuters (both full-time and part-time) felt that FasTrak's technology was working well and that it was relatively easy to purchase a transponder for the car (Godbe Research and Analysis, 1998). However, there was some confusion as to where transponders could be purchased. Respondents were asked questions regarding the transfer of information regarding the level of traffic on I-15, especially regarding the use of a website, a dedicated radio station, and variable message signs. Respondents suggested the creation of a website that would provide up-to-the-minute toll and traffic information, but then responded that they would not use the website due to the lapse in time between checking traffic information and using I-15. The creation of a radio station was a more favorable option to providing information regarding traffic and tolls on I-15. Full-time users were interested in knowing traffic information 1-2 miles before the entrance to the Express lanes, as well as the average speeds of traffic in general lanes compared to Express lanes. Part-time users were also interested in knowing the speed of traffic in the general lanes, as well as information about traffic problems and road closures on roads other than I-15. Variable message signs were also suggested to communicate traffic information and were favored the most out of the three options. Full-time users preferred that the signs display the average speed of traffic in main lanes, while part-time users preferred that the signs display the toll and the average speed of traffic in the general lanes compared to Express lanes. However, all users wanted the signs in symbols rather than words as to not distract drivers and wanted the signs placed above the lanes, rather than on the side of the road (Godbe Research and Analysis, 1998).

Technology Evolution: The Case of Singapore*

Singapore's cordon-pricing project began as the Area Licensing Scheme (ALS) in 1975. As Singapore's pricing scheme is one of the oldest in the world, the technologies used to enforce the cordon have changed over time. In 1998 enforcement was switched from the ALS to electronic tolling.

Under the manual ALS, 150 persons were employed as operators of license sale booths and police officers in control booths at entry points. As the number of different types of licenses increased, police

* This section is drawn from Menon (2006).

had to pay special attention over longer periods of time. In 1992 when Singapore started looking for an electronic road pricing system, there were no comparable systems operating anywhere. Three international contractors took part in a competition to select the best system. In 1998, the manual system was replaced by electronic pricing. ERP gantries were installed at each entry point. The ERP system uses a short-range radio communication in the 2.40 GHz band. Vehicles are outfitted with In-vehicle Units (IU), with a slot for receiving a prepaid stored value smart card called the CashCard. The CashCard is a prepaid contact integrated circuit chip plastic card, and one can add money to the card at ATMs and gas stations. The CashCard can be used for car parking charges and regular purchases.

At each entry point, there are two sets of overhead gantries, 15 meters apart. They have the radio antennae that communicate with the IU of passing vehicles, optical sensors to detect the vehicles, and enforcement cameras to take picture of the rear license plates of vehicles found in violation. A local controller at each outstation houses the monitoring equipment for ERP gantries, and communicates with the central computer system via telephone lines. The main control center receives all the records of ERP transactions and digital photos of violating vehicles. The control center settles all the monetary transactions for the day, sends out violation fine notices, and notifies drivers of vehicles with malfunctioning IUs to take their vehicle in for a free inspection. The consortium of local banks manages the sale of CashCards and reimburses the authorities daily for the ERP transactions.

When a vehicle approaches the first gantry, the radio antenna communicates with the vehicle IU, determines its validity and the vehicle classification, and instructs the IU to deduct the appropriate ERP fee from the CashCard. When there is no valid ERP deduction, the enforcement camera takes a picture of the rear license plate, and the reason for the violation or the error is recorded.

When the motorist inserts a CashCard into the IU, the display shows the cash balance. When the vehicle goes under the ERP gantry, the IU displays the new balance. There is a low balance indicator which appears when the vehicle goes under an ERP gantry with less than S\$5 (US \$3.28) is on the CashCard. IUs are color-coded for different class of vehicles, to prevent swapping. Emergency vehicles and police cars are outfitted with special IUs that do not require CashCards. A visitor can rent a temporary IU at a gas station near the border. Alternatively, a foreigner can drive without an IU and pay an ERP fee of \$5 for each day of driving in the RZ upon departing the country. The system does not conflict with the privacy of travelers, as it only photographs violators.

The ERP operates on weekdays in the RZ, and during peak periods on selected expressway links. There are no restrictions on Saturday. When the monitored speeds for half-hour intervals on the expressway fall below 45kph, or below 20 kph on the arterial roads, the ERP fees are raised for that half-hour period, and vice versa. Currently, the major roads within the RZ all operate within the desired range of 20-30 kph

during the ERP period of 7:30 a.m.-7 p.m. They do not drop for the half-hour before the congestion charge start, but speeds do drop for a 45 minute interval after the congestion pricing ends at 7 p.m. Unlike the ALS system, a driver is charged every time he or she enters the RZ, so multiple trips are limited. The automated system makes it easy to change fees and hours of operation. It is also relatively easy to change the area boundaries of the congestion pricing zone, by installing and removing ERP gantries. The half-hour increment fees are reviewed at three months' intervals and announced via local newspapers (Menon 2006).

Motorcycles constitute about 15 percent of the total vehicle population, and pay half the fee of a light vehicle. There are about 3 violations per 1000 ERP transactions, and the majority of those are due to drivers forgetting to insert the CashCard in the IU. Taxi commuters have to pay the ERP fee that their trip incurs. When a taxi enters the IU empty, the driver has to pay the fee. Taxi fares have been deregulated recently, and there are ample taxis in the city.

A massive publicity program was put out for a year prior to ERP implementation. Motorists were educated on how to use their IU and CashCards. The ERP gantries were in "test mode" for 3 months with zero charging, before the actual start date. That way, motorists could check that their equipment was working.

The annual revenues from congestion pricing account for 0.3 percent of total government revenue, and are only 8 percent of the annual costs of building, maintaining and operating the land transport infrastructure (including both rail and roads). Congestion revenues are not earmarked for transport related projects. The main purpose of new roads being built is to provide access to new areas of development, to fill in missing links in the road network, and to address congestion by widening in problem areas.

Investment in public transport has been an integral part of a successful ERP system. The heavy rail is anticipated to be expanded to 500 km by 2030. Two private companies have signed a long-term licensing and operating agreement to run the train services, without a government subsidy for O&M. The bus fleet, owned by the same two private companies, is benefited by bus lanes and special bus signals, and is the mainstay of public transport, providing a wide coverage without government subsidies. The rail and bus systems are well integrated, with a common ticket used on both, and careful positioning of stations within easy transfer distance of each other.

Conclusions

New technologies now make it considerably easier to establish and enforce a congestion-pricing mechanism, whether the facility is limited to one lane or established as a cordon, as in the case of Singapore. The most widely-used new technologies include electronic toll collection via transponders found in the individual cars. Technologies, such as license-plate reading, automatic vehicle occupancy

detection, and enforcement gantry lights, are also being developed to assist in enforcement. Such technologies allow for the separation of a congestion-priced lane's users into those who do not have to pay the toll (e.g. a vehicle with two or three people inside) and those who do.

Audiences for electronic toll collection and transponder use have often responded favorably and adapted to using the new technology. However, there may be privacy concerns with some of the enforcement technology; users may react negatively to having their license plate read or their picture taken by a digital camera trying to determine occupancy. Any agency trying to establish a new congestion-pricing facility would have to gauge the mood of the public carefully, as a negative reaction to a proposed new technology could lead to negative publicity for the project as a whole.

Public Acceptance of Congestion Pricing

In the past few years, a number of surveys have been conducted as to public perceptions of congestion-pricing projects. While most of these were conducted via telephone, there are two examples of online surveys (Ubbels and Verhoef, 2006; Burris et al., 2007). The most obvious trend, when comparing the various surveys, is that those conducted after a specific congestion-pricing project found more favorable opinions of congestion pricing and tolls than those which were being conducted on the topic of hypothetical tolling projects. Appendix A has a table summarizing the structure and findings of several recent congestion-pricing-related surveys.

Before and after the opening of the MnPASS congestion-pricing facility on Interstate 394 near Minneapolis, NuStats conducted a series of surveys of consumer behavior in the area. Most of the 980 participants in the first of three “waves” of surveys also participated in the second and third “waves” (Zmud et al., 2007). To date the NuStats surveys seem to be the most comprehensive effort at tracking public reactions to a congestion-pricing project over time. The NuStats surveys are included in Appendix A.

Some studies have relied on interviews with participants in past congestion-pricing implementation programs (Evans et al., 2007) or with specific local stakeholders (Benjamin et al., 2007). A few have used focus groups (Godbe Research and Analysis, 1998; Texas Transportation Institute, 2005; Cook Research, 2004) to obtain more detailed user reactions.

How the public regards a travel-demand management measure, such as congestion pricing, depends on a number of factors. Non-coercive measures are more acceptable than coercive measures (Gärling and Schuitema, 2007). The more effective the scheme is perceived to be at solving congestion or environmental problems, the weaker the probable public opposition (Gärling and Schuitema, 2007). Meanwhile, in the United States, the nature of government is inherently biased against significant policy change, and large projects are vulnerable to “last-minute withdrawal” from political actors if public opposition mounts (Ungemah and Collier, 2007).

There is some suggestion that as congestion problems have worsened over time, and as managed-lanes projects in the United States have gained publicity, public attitudes towards congestion pricing have begun to warm. Benjamin et al. (2007), discussing the possibility of adding HOT lanes to a major arterial (Interstate 40) in a medium-sized city (Greensboro, North Carolina, with an estimated population of 237,000 in 2006) found that approximately as many leaders favored tolls for highways as opposed them. Yet American attitudes towards congestion pricing have been characterized as lukewarm at best (Swisher

and Ungemah, 2006), and previous polls have found little support for time-of-day variable pricing (Weinstein and Dill, 2007).

Public Objections to Congestion Pricing

It should be noted, first, that different existing users will have different attitudes towards a proposed congestion-pricing program. Those who already benefit from the free HOV lane, such as transit riders, drivers of super-low-emissions vehicles (SLEVs), and carpoolers, may balk at the idea of sharing the HOV lane with single drivers, even those paying a fee (Swisher and Ungemah, 2006). Regular users of the road on which the proposed project will be implemented may feel differently towards congestion pricing than occasional users.

Value pricing is widely recognized to be politically difficult because it adds a price to a public service previously perceived as free (Benjamin et al., 2007). A survey of travelers in Dallas and Houston found that the primary reason given for opposition to value pricing was dislike of the tolls; a feeling that taxes had already paid for the road was also frequently cited (Burris et al., 2007). The idea of value pricing as “double taxation” is also shared by many American political leaders (King, Manville, and Shoup, 2007). However, in public opinion studies support for tolls to fund roadway projects often increases when directly compared to raising gas taxes (Weinstein and Dill, 2007).

The political acceptability of congestion pricing may also depend on the plans for the revenue (King, Manville, and Shoup, 2007). One study suggested that revenue uses that benefit individual drivers, such as decreasing road or fuel taxes, was more likely to win public support than revenue uses meant to benefit society as a whole (Gärling and Schuitema, 2007). Participants in focus groups for the San Diego I-15 FasTrak reported that while they were unsure of how revenues were being used, they felt that revenues should be used mainly for highway projects. Improving public transportation was cited as a positive use of revenues by some, but overall participants advocated using toll revenues for improving roads and constructing new express lanes (Godbe, 1998). Focus groups in Atlanta recommended that revenues first be used to cover the capital, operations, and maintenance costs associated with converting to or constructing HOT lanes (Meyer et al., 2006).

Several studies have found that prior familiarity with congestion pricing or managed lanes increases the likelihood that the user will support congestion pricing (Kockelman and Kalmanje, 2005; Burris et al., 2007). In the case of the variably-priced HOT lanes on I-394 in the Minneapolis/St. Paul metropolitan area, NuStats conducted three separate surveys; in November/December 2004, before the lane opened; between November 2005 and January 2006, six months after its opening; and a year after its opening, in May-June 2006 (Zmud et al., 2007). One subsequent observation, after a comparison of the results of the three surveys, was that

It seems that when an SP [stated preference] survey is done before respondents have any experience with the actual HOT lane context, their responses may tend to [be] “homogenized” to some extent. After the actual HOT lane system is introduced, on the other hand, respondents may have a much better idea of whether or not they would be willing to pay the toll in specific situations, so their responses will tend to show a wider variance (Zmud et al., 2007).

Moreover, those polled while living in areas without tolls were more likely to consider congestion pricing unfair (Podgorski and Kockelman, 2005).

An additional consideration is the way in which a pricing project is marketed. A study in Oahu found that when pricing was presented as “a time-of-day charge to manage congestion by inducing shifts to transit and travel times,” it only received 15% public approval. But when it was presented as “a user fee wherein those using the facility the most pay the most and where fees go toward road development and maintenance”, it garnered 42% acceptance (Ungemah and Collier, 2007).

Equity Concerns

Previous studies suggest that public opposition to congestion pricing decreases as the toll decreases (Gaunt et al., 2007). Part of this decline can be attributed to simple self-interest, as users may hope that if congestion pricing is actually implemented, the tolls will be minimal. But concerns over the absolute cost of the toll may also be related to the perception that managed lanes will function as “Lexus lanes,” available only to the wealthy. In the second panel survey concerning the MnPASS managed lanes on Interstate 394, the most often cited objection to letting single-occupied vehicles (SOVs) use carpool lanes was that only the rich would benefit; the second-most popular objection was that carpool lanes should be free to all (Zmud, Peterson, and Douma, 2007). The “Lexus lanes” objection was also prominent in early discussions of the I-15 Express Lanes project (Evans et al., 2007).

Ungemah (2007) divides concerns about equity, as relating to congestion-pricing schemes, into five types; participation equity, opportunity equity, modal equity, geographic equity, and income equity; his analysis concentrates on the last two. Geographic equity concerns are similar to environmental-justice concerns in that a community may feel it is being asked to bear the burdens of a particular project seen as regionally beneficial—for example, the community may be host to roads which become more congested as drivers try to avoid tolled roads. Income-equity concerns frequently center around the question of whether an additional toll would be an unacceptable cost burden for low-income communities.

There is some evidence that higher-income potential users suffer less risk from a congestion-pricing scheme than lower-income potential users. Of the respondents to a survey about a potential congestion-pricing scheme in the Netherlands, those with higher incomes were less price-sensitive (Ubbels and Verhoef, 2006). An early look at I-15 FasTrak users found they were more likely to have higher levels of income and education, and to own homes, than non-users (Hultgren and Kawada, 1999). But surveys have not found differences between higher- and lower-income users' attitudes towards congestion pricing (Weinstein and Dill, 2007).

Kockelman and Kalmanje (2005) and Gulipalli and Kockelman (2006) have discussed the possibility of credit-based congestion pricing, or CBCP. In this scenario, all travelers would receive an automatic credit to be applied to tolls. Modeling a CBCP policy in the Dallas-Fort Worth area using three different scenarios, Gulipalli and Kockelman (2006) suggest that a majority of users would receive welfare gains. But CBCP has not been implemented in any of the existing American congestion-pricing programs.

Political Difficulties in Implementing Congestion Pricing Programs

There have been a number of failed attempts to implement value-pricing schemes. Portland, Oregon was unable to convert existing HOV lanes to HOT lanes at several congested locations because the public saw the conversion as a removal of capacity (Sullivan, 2003). A variable-toll program for the Chesapeake Bridge in Maryland was cancelled by the governor, partly on grounds of local concerns (Sullivan, 2003).

In the United Kingdom, although the flat congestion-charge toll has been successfully implemented in London, a road-user charging scheme was voted down in Edinburgh, Scotland, in 2005. The scheme would have set up two cordons around the city, with a one-time charge of £2 for crossing one or both cordons each weekday. Exemptions would have been given to taxis, buses, motorbikes, emergency vehicles, and the disabled, but not to residents of the city. The money would have been put towards transport investment. After a five-stage, three-year public-involvement process, the vote in February 2005 led to a 74.4% rejection of the proposed scheme (Gaunt et al., 2005). The Edinburgh scheme lacked national political support (Gaunt et al., 2005) and thus, as with the Maryland and California schemes, lacked a strong political champion.

Successful managed-lane projects need top-level political support (Swisher and Ungemah, 2006). King, Manville, and Shoup (2007) argue that congestion pricing has historically lacked strong advocates because it lacks a constituency to derive concentrated benefits that exceed the costs. While two groups—drivers for whom the time saved is worth more than the tolls paid, and people who already use transit—benefit from congestion pricing, it hurts those drivers who pay more than their time is worth, drivers who switch to a more convenient route to avoid tolls, and drivers on non-tolled routes who see

traffic increased. This explains why car users mainly voted against the Edinburgh scheme (Gaunt et al., 2005). King, Manville, and Shoup (2007) suggest awarding the revenues collected from congestion pricing to cities, so that city leaders will give their political support to the proposed scheme.

The Texas Transportation Institute (Kuhn et al., 2005), summarizing five years of research, made a series of recommendations as to improving the chance of public acceptance of a congestion pricing program:

- Present the managed lane as an additional choice for commuters.
- Emphasize that managed lanes are not a short-term “band-aid” but one tool in a long-term comprehensive plan.
- Explain that variable pricing increases will increase capacity.
- Assure users, especially users unfamiliar with electronic toll collection, that ETC will not impede already-congested travel.
- Make sure an enforcement mechanism is in place so that users do not suspect that they might pay while others break the law.
- Define and communicate how the resulting revenue will be used from the outset of the project.
- Present pricing as a means to raise revenue for projects that might not otherwise be funded (Kuhn et al., 2005).

Revenue use can become a particularly vexing question for users. In a focus group study with users of the I-15 Express Lanes (Godbe Research and Analysis, 1998), respondents said they did not know how the revenue from the HOT lanes was being spent, and were reduced to making guesses, including paying government employees, being used to build a new freeway, or putting “empty buses” on the road.

A second study, examining congestion-pricing projects in California (both successfully and unsuccessfully implemented), found that the public is more likely to accept a project where the sponsoring agency:

- is responding to a serious congestion or environmental concern;
- keeps stakeholder groups apprised of project details, and solicits their input;
- anticipates effects of the project on surrounding areas, and develops mitigation measures accordingly; and
- mounts a comprehensive public outreach campaign (Evans et al., 2007).

Public Education and Outreach

Support for tolling projects increases when respondents are provided more information about the topic (Weinstein and Dill, 2007). A directed and coordinated public education and outreach effort can provide the public with the necessary information to form opinions about a value pricing or managed lanes project. The successful implementation of I-394 MnPASS, after a decade and several failed attempts,

can in part be attributed to this phenomenon. After a proposal for I-394 HOV conversion to HOT was pulled due to public opposition, Minnesota resurrected the project in 2001 with a revised public outreach strategy for value pricing (supported by a grant from FHWA's Value Pricing Pilot Program) and was successful with project approval in 2003 (Munnich and Loveland, 2005).

Public education and political leadership were viewed by the MnPASS project team as crucial and so they had hired a communications consultant to help coordinate efforts and an engineering firm with to answer detailed questions and support the education component. Recognizing that there is more public trust for an initiative led by an academic institution rather than a governmental agency, the Humphrey Institute at University of Minnesota organized a Value Pricing Advisory Task Force of key, diverse community stakeholders. The public education effort focused on building strong stakeholder relationships. The outreach team held dozens of small group visits with legislators, interest group leaders, state government leaders, municipal officials, and transportation and transit advocates. They also held large group dialogues with civic groups and several public policy roundtable discussions between experts and the public, and conducted marketing research and extensive media outreach to disseminate information (Munnich and Loveland, 2005).

The MnPASS team, through failed and successful efforts, developed a set of "lessons learned" as a reference for other value pricing project teams. These lessons include:

- It is difficult to maximize public outreach efforts without the support of higher-level officials who will share their advocacy with the public. Minnesota's governor participated in conversations with value pricing advocates.
- A "Grasstops" Coalition of community leaders is needed. MnPASS's project team reached out to community leaders, discussed the concepts, and then asked supportive leaders to help contact their constituents and peers.
- An unanswered question (or accusation) can become an accusation believed. Minnesota formed a public outreach team to quickly answer any questions from the public. Common public concerns included technical feasibility, equity, impact on HOV use, and public acceptance.
- Constituents must understand the benefits that they will receive. Minnesota used customized messages (in addition to common themes) for each individual audience. For example, messages to businesses focused on reducing the cost of congestion and increasing reliability while messages to carpool advocates made assurances that they would maintain priority on the HOT lane and have more choices.
- The project team should focus on the benefits offered by value pricing rather than the costs; in other words, use terms that accentuate the positive. Minnesota uses "express lanes" and

“MnPASS” rather than terms that emphasize user costs (like value pricing, congestion pricing, toll lanes, etc.) (Munnichand Loveland, 2005).

Ungemah and Collier (2007) offer additional “lessons” for public education approaches. These include:

- Educate citizens about the current system of transportation funding to serve as a comparison to congestion/value pricing.
- Develop a *simple* message to communicate the concept of congestion pricing/managed lanes to the public. For example, in a survey about Houston’s I-10 HOT lanes, half of non-users were either unaware of QuickRide or misinformed about its logistics.
- Use initial and on-going marketing--it is the key to success. This includes branding the project early on to make it identifiable, as Minnesota did by referring to their project as MnPASS.
- Raise public awareness of why pricing is being pursued instead of using a “traditional” financing scheme, as it is often a means of more efficiently allocating transportation resources and of advancing the financial feasibility of a project.
- Be prepared to answer the revenue-spending question.
- Finally, accentuate the positive.

Conclusions

While there is some evidence that American audiences are becoming slightly more comfortable with the idea of congestion pricing, the idea has not yet been matter-of-factly accepted. Familiarity seems to lead to more positive responses: people who have used a congestion-pricing facility or a toll lane before seem to react more positively to the idea of a congestion-pricing facility than do those who have not. But potential users may react negatively if they believe that a “free” facility is being taken away from them. Turning an HOV lane into an HOT lane may be more acceptable to the majority of users, but it may provoke opposition from existing HOV users. Political support can be difficult to obtain. Users may also cite equity as a concern, fearing that a congestion-free drive will be a privilege limited only to those who can afford it.

There are certain things a public agency can do to mitigate these concerns. First, especially if this is the first proposed congestion-pricing facility in a region, prepare a detailed and comprehensive outreach program. Keep potential users informed as to the features and predicted consequences of the facility, and be willing to adjust the proposal based on their concerns. Second, anticipate heightened scrutiny in some areas, such as the potential equity issues and the planned destination of the resulting revenue. Finally, be able to explain how a congestion-pricing facility will bring benefits to the surrounding area; be able to say what those benefits might be, and why they are worth incurring the costs of a new project.

Case Studies

State Route 91 Express Lanes, California

Background

Figure 6: SR-91 Express Lanes Map



Source: FHWA (2003, Chapter 7)

When it opened in 1995, the tolled facility on State Route 91 (hereafter SR-91) was the only variably-priced road project in the world, and the first example of an Express lane/HOT lane facility in the U.S. Unlike later cases which involved an HOV to HOT conversion, this facility was built as a toll road that allowed free access to HOV 3+ vehicles. The 10-mile, four-lane HOT facility built in the median of SR-91 was completed in December 1995.

The Riverside/State Route 91 Freeway, in Orange County, California, is one of the most heavily congested highways in the United States. Prior to the opening of a tolled facility, peak-period delays of 20-40 minutes were common (Sullivan and Burris, 2006). The SR-91 congestion-pricing facility had a relatively difficult political birth, being approved after a statewide bond issue for highway improvements was narrowly voted down by California voters (Evans et al., 2007). It was eventually completed for \$134 million, of which \$82 million was leasehold and equipment costs (Sullivan and Burris, 2006).

Of interest is the fact that this Express lane facility started out as a for-profit, privately-operated venture. This was one of the four public-private partnerships made possible by AB 680 legislation in California. The state was not responsible for construction costs, and the right-of-way costs were negligible due to the prior availability of space for additional lanes in the median. Under the 35-year franchise agreement between the State of California and California Private Transportation Company (CPTC), the CPTC would construct and operate the facility, with the right-of-way leased from the state. The agreement stipulated that no improvements could be made to the general lanes on SR-91 (the non-compete clause), so that the profitability of the project would not be undermined. In 2002, Orange County Transportation Authority (OCTA) purchased the SR-91 Express lanes and the operational franchise agreement from CPTC for \$207.5 million, at which point the goal of variable pricing on the facility could be focused on maximizing traffic flow, not revenue (FHWA, 2003, Chapter 7).


Implementation and Operations


The HOT lanes are separated from the general purpose lanes by a painted buffer and plastic pylons. All vehicles are issued a transponder, including 3+ occupant carpools. At the end of the 2004–05 fiscal year, there were over 172,000 transponders in circulation (FHWA, 2006).

The physical separation of SR-91 Express lanes from general purpose lanes makes enforcement easier than it would be for a striping-separated HOT facility. Carpool vehicles are required to carry a transponder. SR-91 has a contract with California Highway Patrol (CHP), which covers the costs for all CHP services 24 hours a day and involves monitoring of vehicle occupancies.

The SR-91 case is of utmost importance both because of the length of time it has been in operation and the number of changes that have been made to the tolling system over time. From January 1998 to 2003, HOV 3+ vehicles had to pay 50% of regular tolls (Sullivan, 2000). Beginning in May 2003 (following the change in ownership), HOV 3+ vehicles, motorcyclists, disabled license plate carriers and zero-emission vehicles travel free except when traveling Eastbound, Monday through Friday between the hours of 4:00 p.m. and 6:00 p.m., when they pay 50% of the regular toll. As of July 2007, tolls range from \$1.20 to \$9.50 (see Figure 7, below).

Figure 7: SR-91 Express Lanes Toll Schedule, July 2007

<div>  <div> Toll Schedule Effective July 1, 2007 </div> <div> Eastbound SR-55 to Riverside Co. Line </div> </div>							
	Sun	M	Tu	W	Th	F	Sat
Midnight	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20
1:00 am	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20
2:00 am	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20
3:00 am	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20
4:00 am	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20
5:00 am	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20
6:00 am	\$1.20	\$1.90	\$1.90	\$1.90	\$1.90	\$1.90	\$1.20
7:00 am	\$1.20	\$1.90	\$1.90	\$1.90	\$1.90	\$1.90	\$1.20
8:00 am	\$1.55	\$1.90	\$1.90	\$1.90	\$1.90	\$1.90	\$1.90
9:00 am	\$1.55	\$1.90	\$1.90	\$1.90	\$1.90	\$1.90	\$1.90
10:00 am	\$2.35	\$1.90	\$1.90	\$1.90	\$1.90	\$1.90	\$2.35
11:00 am	\$2.35	\$1.90	\$1.90	\$1.90	\$1.90	\$1.90	\$2.35
Noon	\$2.80	\$1.90	\$1.90	\$1.90	\$1.90	\$2.90	\$2.80
1:00 pm	\$2.80	\$2.65	\$2.65	\$2.65	\$2.90	\$4.50	\$2.80
2:00 pm	\$2.80	\$3.80	\$3.80	\$3.80	\$3.90	\$5.10	\$2.80
3:00 pm	\$2.35	\$4.10	\$4.70	\$4.95	\$4.95	\$9.25	\$2.80
4:00 pm	\$2.35	\$6.85	\$8.00	\$8.50	\$9.25	\$9.50	\$2.80
5:00 pm	\$2.35	\$6.65	\$8.50	\$8.50	\$9.25	\$8.00	\$2.80
6:00 pm	\$2.35	\$4.10	\$5.45	\$4.95	\$5.75	\$4.90	\$2.35
7:00 pm	\$2.35	\$2.90	\$2.90	\$2.90	\$4.15	\$4.55	\$1.90
8:00 pm	\$2.35	\$1.90	\$1.90	\$1.90	\$2.65	\$4.15	\$1.90
9:00 pm	\$1.90	\$1.90	\$1.90	\$1.90	\$1.90	\$2.65	\$1.90
10:00 pm	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.90	\$1.20
11:00 pm	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20

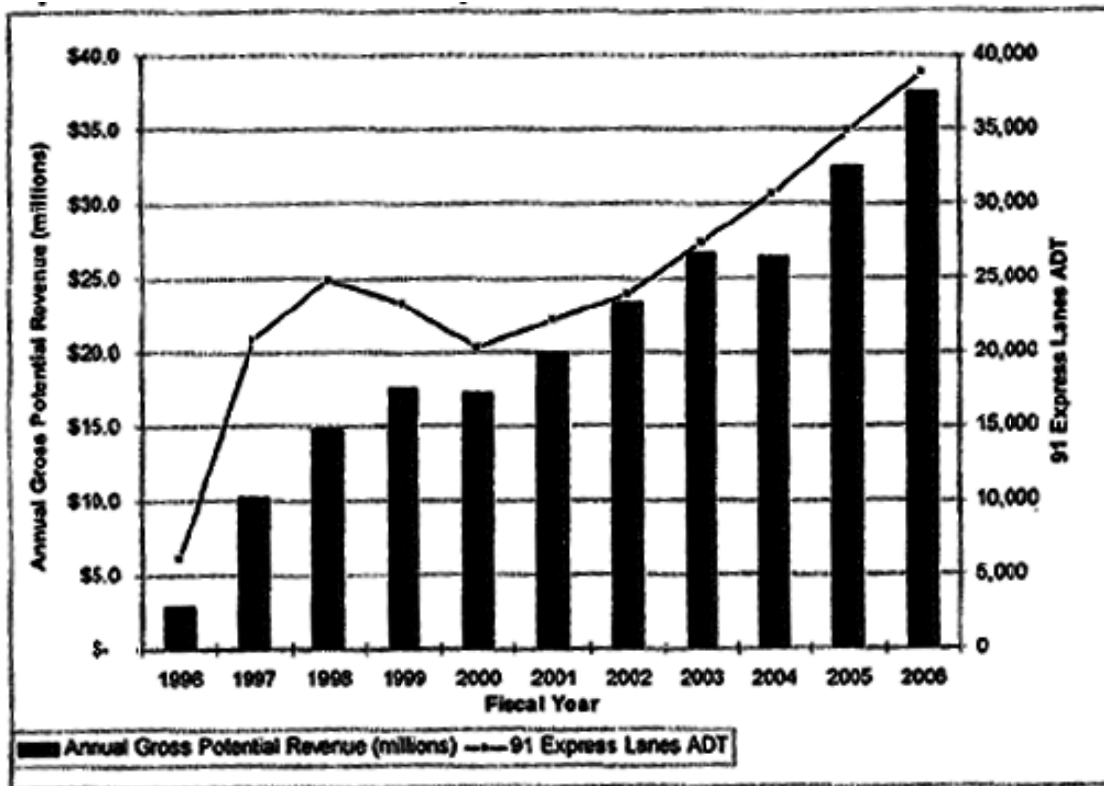
<div>  <div> Toll Schedule Effective July 1, 2007 </div> <div> Westbound Riverside Co. Line to SR-55 </div> </div>							
	Sun	M	Tu	W	Th	F	Sat
Midnight	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20
1:00 am	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20
2:00 am	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20
3:00 am	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20
4:00 am	\$1.20	\$2.25	\$2.25	\$2.25	\$2.25	\$2.25	\$1.20
5:00 am	\$1.20	\$3.70	\$3.70	\$3.70	\$3.70	\$3.55	\$1.20
6:00 am	\$1.20	\$3.80	\$3.80	\$3.80	\$3.80	\$3.70	\$1.20
7:00 am	\$1.20	\$4.20	\$4.20	\$4.20	\$4.20	\$4.10	\$1.65
8:00 am	\$1.65	\$3.80	\$3.80	\$3.80	\$3.80	\$3.70	\$1.90
9:00 am	\$1.65	\$3.05	\$3.05	\$3.05	\$3.05	\$3.05	\$2.35
10:00 am	\$2.35	\$1.90	\$1.90	\$1.90	\$1.90	\$1.90	\$2.35
11:00 am	\$2.35	\$1.90	\$1.90	\$1.90	\$1.90	\$1.90	\$2.70
Noon	\$2.35	\$1.90	\$1.90	\$1.90	\$1.90	\$1.90	\$2.70
1:00 pm	\$2.70	\$1.90	\$1.90	\$1.90	\$1.90	\$1.90	\$2.70
2:00 pm	\$2.70	\$1.90	\$1.90	\$1.90	\$1.90	\$1.90	\$2.70
3:00 pm	\$2.70	\$1.90	\$1.90	\$1.90	\$1.90	\$2.35	\$2.70
4:00 pm	\$2.85	\$1.90	\$1.90	\$1.90	\$1.90	\$2.35	\$2.85
5:00 pm	\$2.85	\$1.90	\$1.90	\$1.90	\$1.90	\$2.35	\$2.85
6:00 pm	\$2.85	\$1.90	\$1.90	\$1.90	\$1.90	\$2.80	\$2.35
7:00 pm	\$2.35	\$1.20	\$1.20	\$1.20	\$1.20	\$1.90	\$1.90
8:00 pm	\$2.35	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20
9:00 pm	\$2.35	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20
10:00 pm	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20
11:00 pm	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20	\$1.20

Source: Orange County Transportation Authority (2007)

Public Response

Use of the SR-91 Express Lanes has grown consistently since the facility opened in 1995. Figure 8 shows historical growth in average daily traffic and gross annual potential revenue (Vollmer Associates, 2007).

Figure 8: Average Daily Traffic and Revenue Growth, SR-91, 1996-2006



Source: Vollmer Associates (2007)

In the 2005–06 fiscal year, the SR-91 Express lanes serviced approximately 38,800 vehicles per day, resulting in \$37.5 million in gross potential annual revenue (Vollmer Associates, 2007). One estimate put the value of time travel saved by the express-lane facility at \$34.9 million in 2005 alone (Sullivan and Burris, 2006).

The SR-91 lanes are not being used exclusively by wealthy drivers, but by a broad swath of society (Evans et al., 2007). A travel profile of SR-91 Express Lane users conducted immediately after its opening found approval from both low- and high-income households (Ungemah, 2007).

Public support for SR-91 did decline after its opening—not because of the addition of a toll, or because of perceived inequities in tolling, but due to the nature of the public-private partnership agreement and the non-compete clause (Collier and Goodin, 2002). Public opposition was also based on the idea that CPTC was making excess profits off high tolls. When OCTA bought the SR-91 facility from CPTC, those concerns subsided.

Interstate 15 Express Lanes, San Diego

Background

Figure 9: I-15 Express Lanes Map, San Diego



Source: FHWA (2003)

Unlike subsequent congestion-pricing programs in the United States, the I-15 Express Lanes were not created primarily to reduce congestion, but to create an additional source of revenue with which to fund public transit in the area (Evans et al., 2007). The idea of variably-priced lanes was first considered by the San Diego Association of Governments (SANDAG) in 1991. Jan Goldsmith, then mayor of Poway, a city northeast of San Diego, and member of SANDAG's board, would function as the Express Lanes project's champion (Evans et al., 2007; Hultgren and Kawada, 1999). For example, Goldsmith was able to have the California state legislature pass an exception to the rule allowing only HOV-2+ vehicles to use HOV lanes, so that the I-15 Express Lanes demonstration project could be built (Hultgren and Kawada, 1999).

The conversion from HOV lanes, implemented in 1988, to HOT lanes took place gradually. During the demonstration phase, which lasted from December 1996 to March 1998, solo drivers could purchase monthly passes to ride in the Express Lanes, while carpoolers could ride for free (much like the process currently in use on the HOT facility in Salt Lake City, Utah). FasTrak transponders were not issued until

the second phase, which began in March 1998 (Brownstone et al., 2002). Capital costs of converting HOV lanes to HOT added up to \$1.85 million (Poole and Orski, 2000).

Implementation and Operations

The I-15 FasTrak is an eight-mile, 2-lane peak-period reversible HOT facility. HOV2+ vehicles may use the facility at no cost. There are only two entrance/exit points — one at either end of the eight miles. There are two lanes at the center of the right of way that are separated from the general purpose lanes by permanent barriers. The lanes run eight miles southbound into San Diego from 5:30 am to 11:00 am. The lanes are then reversed and they run northbound out of San Diego from noon until 7:00 pm. The lanes are only closed for the short period (about 1 hour) that is required to reverse the direction of travel and on weekday evenings (7:00 pm to 5:30 am the following day). The lanes operate northbound at present on Saturdays and Sundays.

Figure 10: Current configuration of managed lanes on I-15



Source: FHWA and FTA (2006)

The goal of the I-15 facility is to manage congestion, while keeping the level of service (LOS) at C or better. The toll level is changed according to the congestion level. Loop detectors are used to measure the volume of vehicles on the lanes. The toll, which is set dynamically (based upon real-time traffic conditions), usually ranges from 50 cents to \$4 (although it can be set as high as \$8), and is updated automatically every six minutes.

The toll is charged only to single occupant vehicles (SOV). High occupancy vehicles (HOV), containing two or more passengers, are exempt from the toll. FasTrak transponder users are given special bags (static bags) in which to place the transponder when their vehicle has 2 or more occupants. The static bags prevent the transponders from being read and prevent charges from appearing on user accounts. Toll enforcement is an issue that is difficult to address and the San Diego region is still looking for better methods. Tolls are charged electronically and there are currently about 30,000 toll transponders in circulation. However, approximately 77% of the traffic is HOV vehicles. There was an increase in usage when FasTrak transponders were introduced to allow users to pay to access the lanes. If HOV and transit

vehicles ever produced LOS C (or worse) without the tolled vehicles, the HOV requirement would be raised to 3 occupants or more.

Revenue for the I-15 lanes is \$2 million per year, which is split evenly between transit and facility operations. The \$1 million designated for transit supports the Inland Breeze bus service. (FHWA and FTA 2006). A planned expansion, to be completed by 2012, will extend the Express Lanes to more than 20 miles and will include a bus rapid transit (BRT) system (FHWA and FTA, 2006).

Public Response

Members of a 1998 focus group said they were generally satisfied with the Express Lanes program, although regular users spoke more positively of the program than occasional users (Godbe Research and Analysis, 1998). According to the results of an 800-person telephone survey of I-15 Express Lane users completed in 2001, motorists of all income levels are able to recognize the benefits of HOT lanes:

- 91 percent of those surveyed approved of the travel time savings options provided by the I-15 Express Lanes;
- 66 percent of non-Express lane users support the Express Lanes concept;
- 73 percent of non-Express Lanes users agree that the HOT lane reduces congestion in the corridor;
- 89 percent of Express Lanes users support the extension of the Express Lanes; and
- when considering the statement “People who drive alone should be able to use the I-15 Express Lanes for a fee,” 80% of the lowest income motorists using the I-15 corridor agreed with it, and low income users were more likely to support the statement than the highest income users (FHWA, 2003).

In effect, such results diffuse the equity concerns raised in regards to HOT lanes and their potential higher usage by high-income populations.

The case of San Diego has suggested that converting an HOV lane to an HOT lane is not as politically charged as creating a new congestion-priced lane, since SOV drivers gain, rather than lose, options (King, Manville, and Shoup, 2007).

Houston QuickRide, I-10 and US-290

Background

The QuickRide program has been implemented on two interstate highways that feed into Houston from the west, Interstate 10 and US-290. The former is also known as the “Katy Freeway” and the latter as the “Northwest Freeway” (see Figure 11). Both highways had existing HOV lanes prior to the HOT

conversion. The first HOV lanes in the Houston area were built in 1979; the Katy HOV lane opened in 1984 (Burris and Stockton, 2004). By the mid-1980s, state officials had learned that if vehicles with just two people inside (HOV-2 vehicles) were permitted to use the lane, it rapidly became congested during peak hours, but allowing only vehicles with three or more people inside (HOV-3+ vehicles) led to an inefficient use of existing capacity (Burris and Stockton, 2004). Thus the idea of allowing HOV-3+ users to use the lanes for free, while charging HOV-2 users, arose as an adjustment to observed traffic conditions over time.

Figure 11: Map of Katy Freeway and Northwest Freeway



Source: Texas Transportation Institute (2003a)

Figure 12: Katy Freeway (I-10 West) HOT Lane



Source: Turnbull (2003)

Implementation and Operations

The Katy Freeway HOV lane was converted to an HOT lane in January 1998, and the Northwest Freeway HOV lane to an HOT lane in November 2000. In both cases, the lanes are reversible and restricted to use by HOV 2+ vehicles. HOV 3+ vehicles travel for free, while vehicles with two people must pay \$2 during the congestion periods. As Table 1 shows, the hours of operation differ between the Katy Freeway and the Northwest Freeway.

**Table 1: Hours of Operation, Houston QuickRide
(asterisk denotes application to Katy Freeway only)**

Days Open	Hours of Operation	Direction	Minimum Capacity
Weekdays	5 to 6:45 a.m.	inbound	2
	6:45 to 8 a.m.	inbound	3
	QuickRide		2
	8 to 11 a.m.	inbound	2
	2 to 5 p.m.	outbound	2
	5 to 6 p.m.*	outbound	3
	QuickRide*		2
	6 to 8 p.m.	outbound	2
Saturday*	5 a.m. to 8 p.m.	outbound	2
Sunday*	5 a.m. to 8 p.m.	inbound	2

Source: Texas Transportation Institute (2003)

Enforcement on Houston HOV and HOT facilities is provided by METRO police officers, with the goal of providing safe and efficient operation. At least one METRO police officer is located in the HOT lane corridor during operational hours, responsible for patrolling and monitoring the corridor for violators of the occupancy requirement and other regulations. Specific enforcement areas are set up to not interfere

with the flow of traffic, at the entrance points to the facility (see Figure 13 below). The presence of concrete barriers simplifies the enforcement task (Cothron, Skowronek et al., 2003).

A HERO self-enforcement program is in effect in the Houston area, where a dedicated phone number is available for motorists to call and leave a message if they notice a driver who violates the rules of an HOT or HOV facility. The reported violator receives a warning letter from the METRO police (Cothron, Skowronek et al., 2003). Such a program can be useful for mailing educational materials, even if it does not have the “teeth” to fine the reported violator.

Figure 13: A motorist passes through an enforcement zone while heading westbound on the I-10 Katy Freeway in Houston, TX



Source: Obenberg (2004)

Future expansion and changes to the QuickRide program are likely. One stated-preference survey, conducted in late 2003, suggested that single-occupancy vehicle drivers would pay to use the QuickRide facilities, given sufficient time savings. Based on the survey, Burris and Xu (2006) propose an off-peak toll schedule for SOVs that would allow approximately 2,000 more QuickRide users and generate approximately \$4,500 in additional revenue per day. As of July 2007, however, QuickRide was not open to single-occupancy vehicles (Texas Transportation Institute, 2003).

Public Response

As of April 2002, over 1,500 transponders were in circulation for use on the two facilities, and an average of 160 users traversed the two facilities each day (FHWA, 2003). One estimate put the value of time savings over ten years of QuickRide use at \$2.35 million, and fuel savings at \$13,500 (Burris and Stockton, 2004).

Burris and Hannay (2003), surveying both users and non-users of QuickRide in 1998, found that while there were no significant differences in perceptions or usage of QuickRide amongst different socioeconomic groups, the surveyed users of QuickRide had significantly higher incomes than non-enrolled drivers.

MnPASS, Interstate 394, Minnesota

Background

Figure 14: I-394 HOT Facility



Source: Minnesota DOT (2007 B)

Interstate 394 runs 9.5 miles, with its eastern terminus in Minneapolis and its western terminus in Minnetonka. As such it serves as a route for commuters from the western suburbs of the Minneapolis-St. Paul metropolitan area to drive into downtown Minneapolis. Previously existing HOV lanes were converted to variably-priced HOT lanes in May 2005. The goal of the MnPASS HOT system is to maintain the free-flow nature of the managed lane and improve the overall effectiveness of the corridor (Douma, Zmud, and Patterson, 2005).

The managed lanes on Interstate 394 came about only after several setbacks. In 1996 a proposed public-private partnership to build a toll road on Minnesota Highway 212 (now incorporated into Highways 5 and 36) was abandoned after local opposition led to a city council veto. A year later, the state Department of Transportation (MnDOT) floated the idea of converting the existing HOV lane to an HOT lane; that, too, attracted local opposition, including the placement of full-page anti-HOT ads in newspapers by a local political leader (Munnich and Loveland, 2005). In the time between the rejection of the HOT plan in 1997 and its endorsement by Minnesota's then-governor in 2003, MnDOT and the Hubert H. Humphrey Institute of Public Affairs at the University of Minnesota used a Value Pricing Advisory Task Force to solicit information from stakeholders, and embarked on an education campaign for the public (Munnich and Loveland, 2005).

One advantage for the MnPASS system was that it was financed not by a public bond issue, but by a loan from a downtown parking ramp fund. The state legislation which authorized the adaptation of the existing HOV lane to an HOT lane requires that a portion of any excess revenue will go to transit improvements in the corridor (Munnich and Buckeye, 2007).

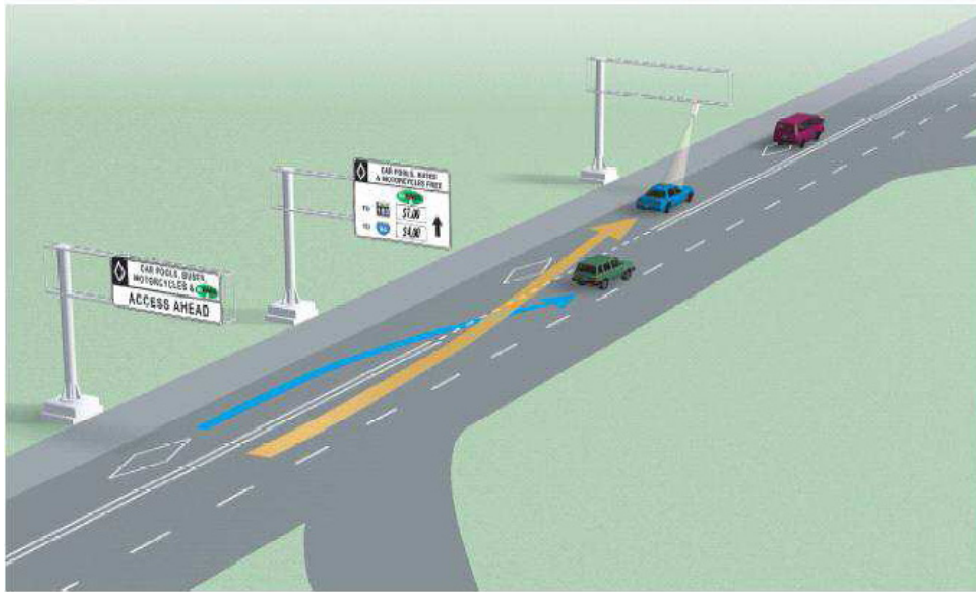
Implementation and Operations

The MnPASS facility consists of a 3-mile section east of I-100 with 2 barrier-separated reversible lanes (eastbound 6 a.m.–1 p.m.; westbound 2 p.m.–5 a.m.) and an 8-mile section west of Interstate 100 with one HOT lane in each direction, with the HOT lane separated from the general-purpose lanes by a 2-foot-wide double white line. Using plastic pylons was not feasible on the project due to incompatibility with snow plows during winter conditions, and building a concrete barrier is not in the plans due to engineering constraints (Halvorson, Buckeye, et al., 2006). Toll revenue is re-invested in the corridor (Douma, Zmud, and Patterson, 2005).

The 8-mile section separated from the general traffic by double white line allows for multiple entry points. Each stripe is eight inches wide, with an eight inch space between the lines, for a total width of two feet. While the double-white strip buffer has not been previously used in Minnesota, it has been successfully used at other U.S. locations to delineate HOV lanes. It is illegal to cross the double white stripe, and violators are subject to fines (Halvorson, Buckeye et al. 2006).

At designated entry and exit points, the double white stripe is replaced by a dashed line, which is legal to cross (see Figure 15, below). Most access points are over one half mile long (with at least a quarter mile required) (Halvorson, Buckeye et al. 2006).

Figure 15: Line-Separated HOT Lane Entry and Egress



Source: Halvorson, Buckeye et al. (2006)

Because the facility has multiple entry and exit points, tolls vary not only by time of day but also by distance traveled. The enforcement presents a special challenge, due to the possibility of illegal weaving in and out of the lane, as well as occupancy violation. Drivers caught crossing the double white line receive a \$142 moving violation fine (Minnesota DOT 2007b). The Minnesota State Patrol oversees the enforcement, assisted by the City of Minneapolis Police Department, Metropolitan Transit Police and the City of Golden Valley Police Department. While police officers rely on visual verification, technological advances, such as overhead gantry lights and MERs, discussed previously, help the better monitor the electronic tolling aspect. The annual cost of enforcement amounts to about \$200,000 (Buckeye, 2007).

Compared with pre-MnPASS violation rates in the HOV facility, the violation rates on I-394 have decreased. In particular, in the stripe-separated section of the corridor violation rates fell from 20% to 9% (Cambridge Systematics, Inc. et al, 2006). Table 2 (below) illustrates the comparison, with an example of violation increase on a non-MnPASS corridor.

Table 2: Summary Comparison of Pre- and Post-MnPASS HOV Lane Violation Rates

Location	Pre-MnPASS	With MnPASS
I-394 Reversible Section	7%	4%
I-394 Diamond Lane Section	20%	9%
I-35W HOV Control Section	23%	33%*

*I-35W control corridor not equipped with MnPASS.

Source: Cambridge Systematics, Inc. et al. (2006)

When interviewed, representatives of three of the four transit providers (Metro Transit, Plymouth Metrolink, and Prior Lake Laker Lines) indicated that the implementation of MnPASS on I-394 has had a negligible effect on their operations and travel times (Cambridge Systematics, Inc. et al., 2006).

The traffic volume in the MnPASS has increased after implementation of the program, yet the travel speeds have not been negatively affected. It appears that the pricing algorithm worked well to maintain the speeds in the HOT lane, with a minor exception at one observed location. In the general purpose lanes, the traffic volumes have slightly decreased, and the travel speeds have experienced a minor increase. This relative increase is mostly felt on days with highest traffic volumes, or when incidents occur. It appears that MnPASS program has been effective in mitigating the delay on the worst travel days, and decreasing the travel time variability in the corridor (Cambridge Systematics, Inc. et al. 2006).

Public Response

When the variably-priced HOT lanes opened on May 17, 2005, about 4,000 electronic transponders had been leased. By the end of 2005, that number had more than doubled, to 9,300 (Halvorson and Buckeye, 2006). In 2007, MnPASS reported more than 11,100 transponders leased (Minnesota Department of Transportation, 2005). Munnich and Buckeye (2007) report that the MnPASS users use the lane about twice a week on average, less often than expected.

Public response to the MnPASS lanes seems to have been largely favorable. By 2006 nearly 60% of the surveyed public in Minnesota supported the option to pay a fee and bypass congestion (Halvorson and Buckeye, 2006). Despite continued concerns that the I-394 lanes would disproportionately benefit wealthier drivers, drivers of all income levels use the lane (Munnich and Buckeye, 2007). A 2007 *Wall Street Journal* article on the MnPASS lanes included positive quotes from drivers, although a representative of the American Automotive Association's Minneapolis branch expressed the organization's position that the lanes should be available to all drivers at all times (Machalaba, 2007).

The NuStats surveys found that support for the project was strong, with nearly two-thirds of those polled saying that allowing SOV drivers in the HOV lane for a fee was a good idea (Zmud et al., 2007).

Through surveys conducted after the MnPASS implementation, it was found that MnPASS users have a positive view of HOT lanes performance (see Table 3, below).

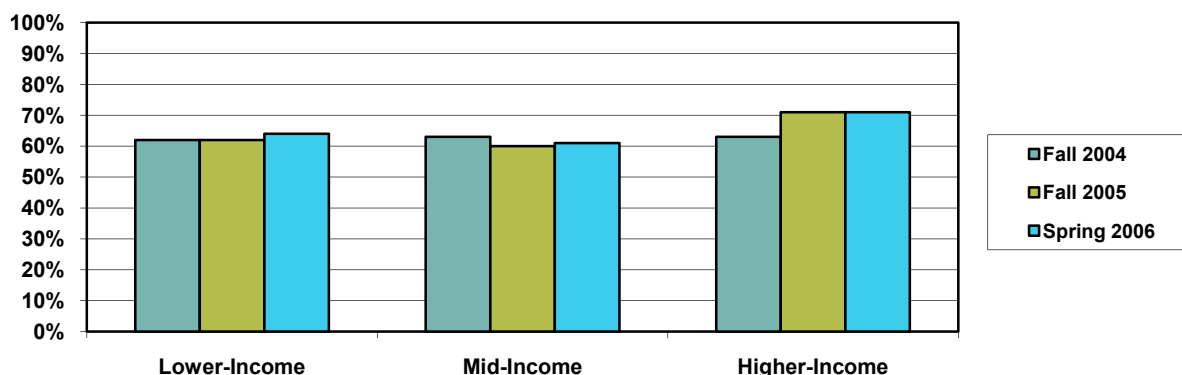
Table 3: Results from MnPASS User Surveys

Percentage of those surveyed...	
Who reported satisfaction with traffic speeds in the HOT lanes	88%
Who reported satisfaction with dynamic pricing	65%
Who reported satisfaction with safety of merging	65%
Who described their travel experience as “enjoyable”	68%

Source: NuStats (2006); Berman (2007); Minnesota DOT (2007a)

In addition, the approval of HOT lanes is widespread across various income groups (Figure 16). Sixty-five percent of respondents to the survey conducted in spring of 2006, a year after MnPASS implementation, thought that MnPASS was a good idea (NuStats, 2006).

Figure 16: Percentage of Minneapolis Consumers Surveyed Who Approve of Allowing Single-Occupancy Drivers to Use the Carpool Lane for a Fee



Source: Berman (2007)

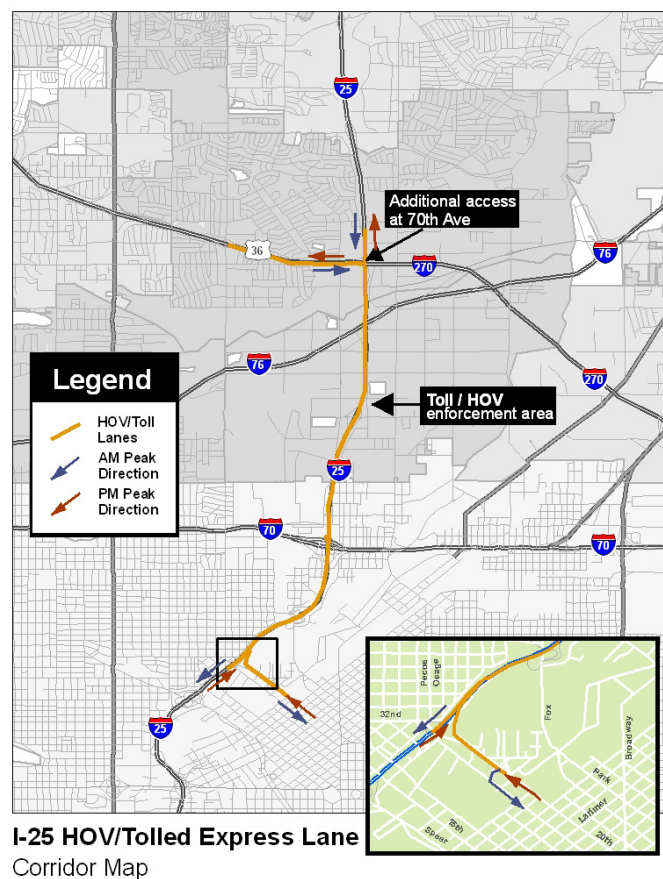
One early setback actually may have increased the credibility of the MnDOT in managing the MnPASS lanes (Munnich and Buckeye, 2007). Soon after the MnPASS facility opened, westbound (reverse-commute) commuters in one portion of I-394 began experiencing greater congestion in the general purpose lanes. The immediate public outcry was answered by an adjustment in the hours of operation for

the MnPASS, giving more access to general-purpose users. The addition of an auxiliary lane in the fall of 2005 further reduced congestion, and the negative feedback quickly subsided.

Interstate 25/US-36, Colorado

Background

Figure 17: Map of I-25 HOV/Tolled Express Lanes



Source: Colorado DOT (2007 C)

The Colorado Department of Transportation (CDOT) opened reversible, high-occupancy vehicle lanes (HOV) on the 7-mile stretch of I-25 between Denver and US-36 in 1994. However, the lanes had significant unused capacity because they carried fewer cars than the adjacent general-purpose lanes (Stegman, 2007). As in Houston, the HOT program evolved as a way to take advantage of that unused capacity.

In the summer of 2002, the Federal Highway Administration awarded 12 pilot projects in value pricing, including the possible conversion of HOV lanes on I-25 in Denver to HOT lanes (*Engineering News Record*, 2003). The conversion of HOV lanes to HOT lanes would include the installation of plastic pylons, message signs, and transponder equipment.

The North I-25 Front Range EIS, the three-year study contracted by the CDOT, was undertaken in 2004 to determine the “effect of adding various transportation improvements in northern Colorado on the lives of residents and commuters in the area,” focusing on the addition of lanes and safety features on I-25 among others. The study area included 70 miles of I-25—north from Wellington, south to Denver, east from US-85 and west to US-287. This area incorporated seven counties and two metropolitan planning groups (McCombs, 2005).

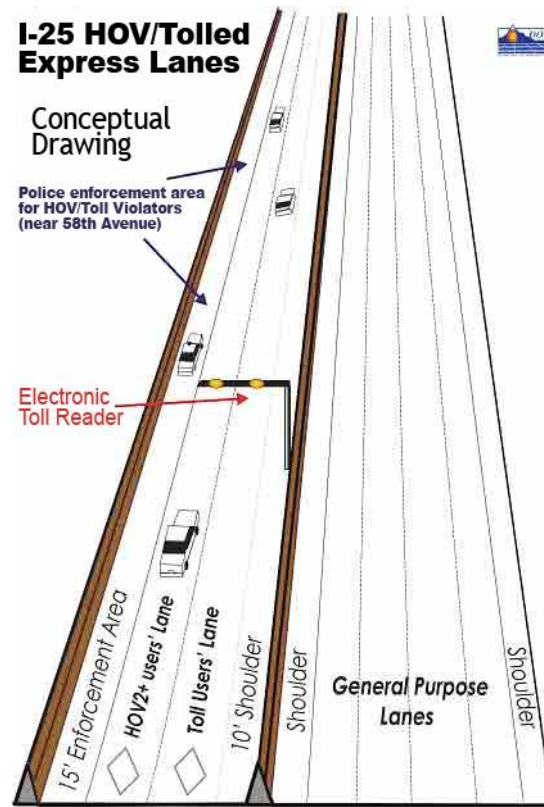
The Denver HOT lanes were influenced by a Denver metropolitan area resident survey that determined that 67.9% of residents believed that the creation of these lanes was an effective way for funding additional highway lanes. The study also found that 74.4% of residents preferred tolled lanes over increasing taxes.

On June 1, 2006, express lanes and high-occupancy toll lanes along 7-mile stretch of I-25 between Denver and US-36 opened. CDOT received a Federal Value Pricing Grant of \$2.8 million from the US Department of Transportation to start the program. The program was implemented in partnership with transportation agencies of the area, including Denver’s Regional Transportation District (RTD), the Denver Regional Council of Governments (DRCOG), the City and County of Denver, the Federal Highway Administration, and the Federal Transit Administration. The total cost of the program was approximately \$9 million and included two feasibility studies, technology components, construction, and a reserve fund for two years of maintenance and operation costs. Originally funded using the grant and taxpayer money, the HOT program is now completely funded by toll revenue.

Implementation and Operations

The facility consists of a 6.6-mile-long stretch of 2 reversible, barrier-separated lanes and one tolling station. The transponder used is the same as the one used on E-407 (outside Toronto) and in Houston. One of the lanes is reserved for HOV vehicles, while the other lane is meant for vehicles paying a toll. An additional 15-foot enforcement lane allows police car access for enforcement. Camera enforcement is used in addition to police patrols. Drivers pay between \$0.50 and \$3.25 per trip. Figure 18 illustrates the configuration of the I-25 HOT Lanes.

Figure 18: Configuration of I-25 HOT Lanes



Source: Colorado DOT (2007 B)

Due to the barrier separation, limited number of entry and egress points, and space for a 15-foot-long enforcement lane, the enforcement efforts on I-25 Express lanes have been quite successful. As the cars pass through the tolling point, they separate into two lanes by status (SOVs and HOVs). Self-declared HOVs go free, and SOVs pay a charge via a transponder. A police officer can monitor from a location adjacent to the tolling point. If a carpool vehicle goes through the toll lane by mistake, the driver will either receive a charge on their transponder (if present), or a violation ticket in the mail, just like a SOV driver without a transponder. If an SOV driver tries to use the HOV lane illegally to avoid toll, the police officer monitoring the facility can issue a citation (Colorado DOT, 2007b).

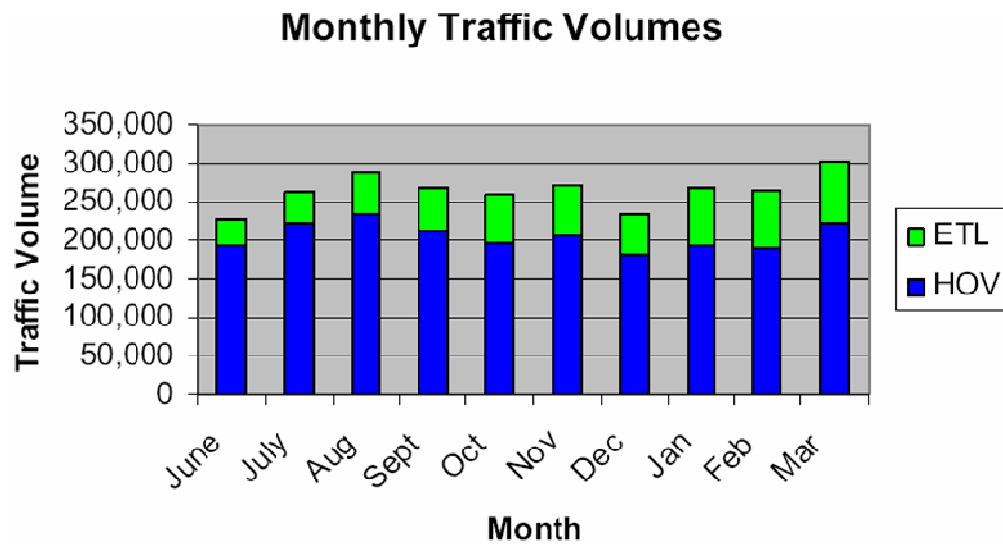
Table 4, below, shows the number of citations issued on Interstate 25 between June 2006 and March 2007. Both toll citations and HOV citations have declined since the first month of operations, suggesting that users might be adjusting to the new facility rules.

Table 4: Citations, I-25 Express Lanes, June 2006–March 2007

	Total Stopped	Toll Citations	HOV Citations	Hazardous Citations	Seatbelt Citations	All Other Citations	Arrests
June	320	43	59	22	5	7	1
July	152	20	26	24	7	19	1
August	127	19	18	45	11	37	1 (DUI)
September	88	7	7	26	4	7	
October	42	5	8	15	4	73	
November	56	0	0	14	7	3	
December							
January	36	2	4	9	1	10	2 (misd)
February	78	13	15	34	8	24	
March	127	6	18	46	10	32	1

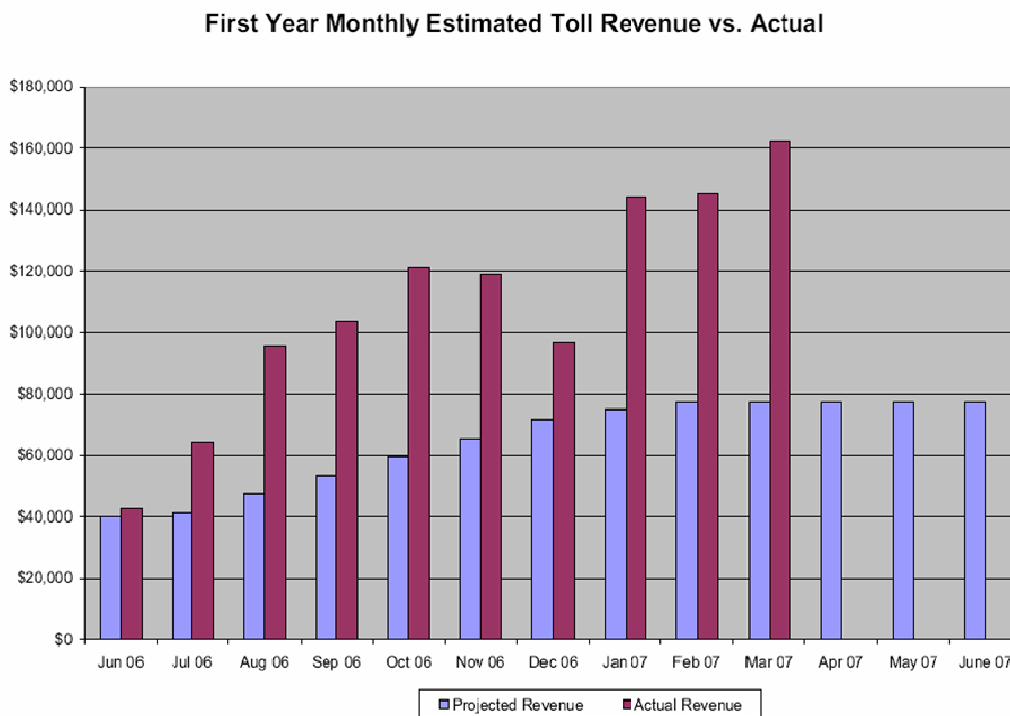
Source: Colorado DOT (2007 A)

Figure 19: I-25 HOT Monthly Traffic Volumes, June 2006–March 2007



Source: Colorado DOT (2007a)

Figure 20: I-25 Projected and Actual Revenue, First 10 Months of Operation



Source: Colorado DOT (2007)

Unlike the MnPASS project, early revenue collection from the I-25 HOT lanes have exceeded projections. Between the opening in June 2006 and late March 2007, revenues of \$1.58 million had been collected; the Colorado Department of Transportation (CDOT) had expected to collect \$800,000 the first year (Cada, 2007). Peggy Catlin, the Deputy Executive Director of CDOT and the Acting Director of the Colorado Tolling Enterprise, testified in a Congressional hearing in June 2007 that the I-25 congestion pricing project was “off to a solid start” but added, “The project’s success has been and is still largely dependent upon public perception and partner relationships” (Catlin, 2007).

Conclusions

The five case studies presented here differ in terms of age of project, initial purpose, method of enforcement, and problem addressed. San Diego hoped to raise more money for transit; Houston and Colorado were trying to put their HOV lanes to more efficient use; the SR-91 and MnPASS projects were undertaken for congestion relief; the Colorado project was in part spurred on by increased FHWA interest in congestion pricing. It is clear that there is no set “formula” for a congestion-pricing facility.

However, we can note some similarities between the five cases. All five have barrier-separated sections; four have reversible sections. Four of the five are able to balance HOVs and SOVs in the same lane; while enforcement has been a difficulty, it should be recognized that a congestion-priced lane can accommodate both carpoolers and single drivers. We can tentatively conclude that (with the exception of SR-91, which had the additional variable of a prominent public-private partnership coming under fire) all show a trend of consumer acceptance of the congestion-priced facility rising after it opened. This is true whether or not SOVs have been allowed to use the facility. Thus, it may be that the most difficult obstacles for a congestion-pricing project are faced before implementation can begin.

Summary: Case Studies

Project	State	Project Website	Type of Congestion Pricing	Main Challenges	Public Response
SR-91 Express Lanes	CA	http://www.91expresslanes.com/	Barrier-separated HOV-3+/HOT lane	Implementation was politically difficult; public reacted strongly against public-private partnership after lane had gone into use.	Generally positive once the lane was returned to public control.
I-15 Express Lanes	CA	http://www.sandag.org/index.asp?classid=29&fuseaction=home.classhome	Reversible, barrier-separated HOV-2+/HOT lane	Toll enforcement, and distinguishing between HOVs-2+ (who do not pay the toll) and SOVs (who do).	Less of an initial negative reaction than in other cases, since the lane was converted from an existing HOV lane.
Houston Quickride	TX	http://www.quickride.org/	Reversible, barrier-separated HOV-3+/ HOT-2 lane	Balancing access between HOV users and toll payers for maximum efficiency.	Somewhat positive, but because use is limited to HOVs-2+, number of users is lower than with other cases.
I-394 MnPASS	MN	http://www.mnpass.org/	HOV-2+/HOT lane, with one barrier-separated reversible section and one section separated by striping	Initial political opposition to congestion pricing had to be overcome; enforcement remains an issue.	Has been increasingly positive as users have become more familiar with the system.
I-25/US-36	CO	http://www.dot.state.co.us/CTE/ExpressLanes/index.cfm	Reversible, barrier-separated area with separate lanes for HOV-2+ and SOVs.	Coordination between the multiple municipal and county governments that stood to be affected by the facility.	Revenue collection has been higher than predicted. Public surveys before facility was built expressed a preference for HOT lanes over increased taxes.

Other Examples of Congestion-Pricing Projects

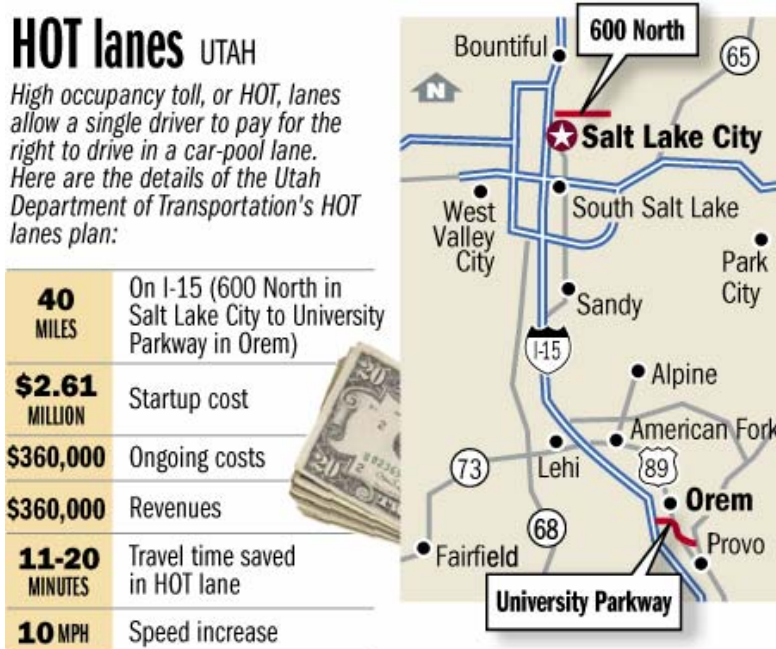
Introduction

So far this review has concentrated mainly on five case studies. However, as congestion has increased in cities throughout the world, congestion-pricing projects have attracted worldwide attention. In this final section, we review innovative pricing projects both inside and outside the United States. While these projects may be harder to draw universal lessons from, because they are new (or proposed) or because the circumstances are so unique, they give an idea of how congestion-pricing strategies can be adapted to different environments.

Within the United States

Salt Lake City

Figure 21: Map of HOT Lanes on I-15, Utah



Source: Warburton (2006)

The 38-mile-long, non-barrier-separated HOT facility in Salt Lake City is the most recent and the longest addition to the list of HOT lanes in the United States. Converted from previously existing HOV lanes, I-15 Express Lanes (one in each direction) are double solid white line separated, with 16 access points

marked by a white dotted line. Each access point is 3,000 feet long. HOV-2+, motorcycles, emergency vehicles, buses, and clean-fuel vehicles can use the lanes for free.

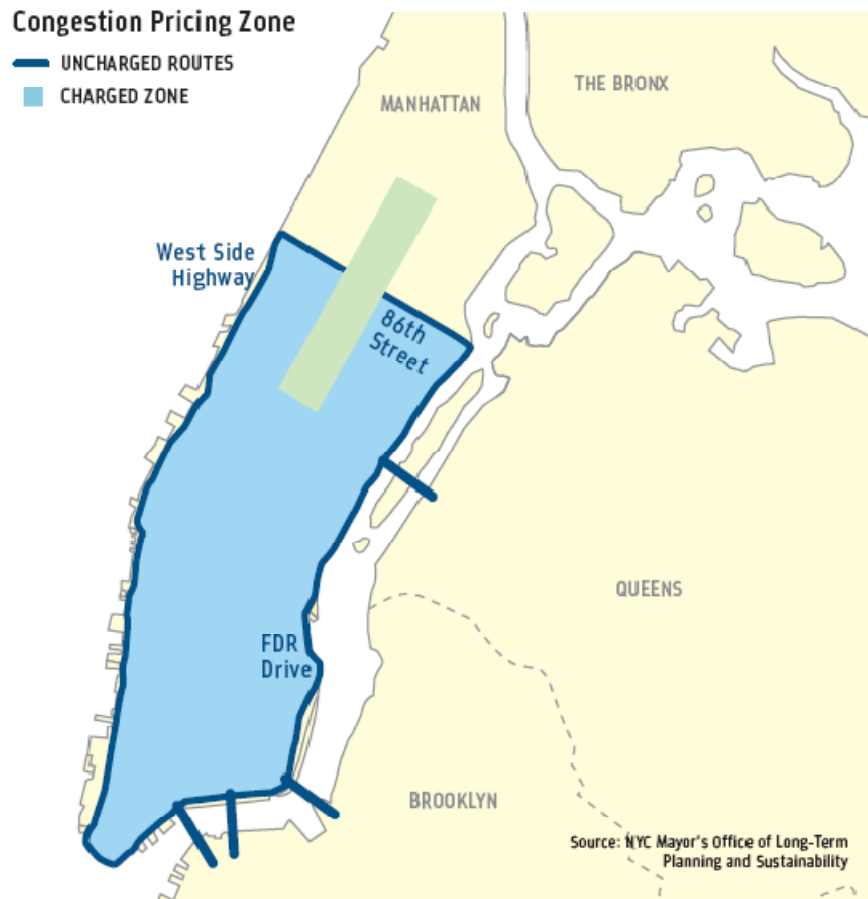
The pricing and enforcement scheme is fairly simple: SOVs can buy a monthly decal for \$50, and each month's decal is in a different color. Once a driver signs up for the program, he or she is automatically issued a new decal each month. Utah Highway Patrol officers are responsible for HOT lane enforcement. A solo driver using the lanes without a decal is issued a citation with a fine of \$92 in Salt Lake County and \$82 in Utah County (Utah DOT, 2006).

One lane on I-15 is estimated to have a capacity of 1,500 cars, and can preserve a minimum speed of 55 mph during peak travel times. Before conversion, the HOV Lanes carried between 650 and 750 vehicles per lane per hour. Currently, up to 1350 solo drivers per month can purchase the decal and use the Express Lanes. Monitoring of the lane ensures free-flow conditions. The price and number of decals sold are subject to change to ensure that speeds in the Express Lanes do not drop below 55 mph. The facility may be converted to electronic tolling in the future, at an estimated cost of around \$15 million (Utah DOT, 2006). While this pricing scheme can be seen as a first step towards introducing variable pricing in combination with electronic tolling, as it was done on I-15 Express Lanes in California, at this point the system cannot be classified as variable pricing. If the facility were to become congested under the current rate structure, implementing a different rate structure would require a significant time lag (at least a month, until drivers renew their decals).

Manhattan

On April 22, 2007, Michael Bloomberg, the mayor of New York City, announced a proposed cordon-pricing scheme for Manhattan. Figure 22 shows the proposed cordon area (the green rectangle is Central Park). Based on London's cordon scheme, the congestion zone would be in effect on weekdays between 6 am and 6 pm. Cars would be charged \$8 daily, and trucks \$21, to enter, leave, and move within the zone. Cars with handicapped license plates, taxis, emergency vehicles, and transit buses would be exempt (City of New York, 2007).

Figure 22: Proposed Cordon Pricing for Manhattan



Source: Office of the City of New York (2007)

The mayor's report predicted that congestion within the charged zone would decrease by 6.3% and traffic speeds would increase by 7.2%; moreover, it predicted, only 1.4% of travelers would refuse to enter the zone at all in order to avoid paying the fee (City of New York, 2007). Nonetheless, political opposition has run strong in New York's state legislature, which would have to approve any plan. The strongest opposition has come from representatives of suburban commuters. Charles J. Fuschillo, Jr., a New York state senator who represents parts of Nassau and Suffolk counties, told the *New York Times*, "It's just another version, in my opinion, to hit Long Island residents with a significant yearly fee" (Confessore, 2007). Although, in Bloomberg, the New York cordon-pricing project has the strong political advocate that many congestion-pricing projects have lacked in the past, the particular nature of New York state politics may delay or completely inhibit the implementation of a Manhattan cordon.

New York / New Jersey

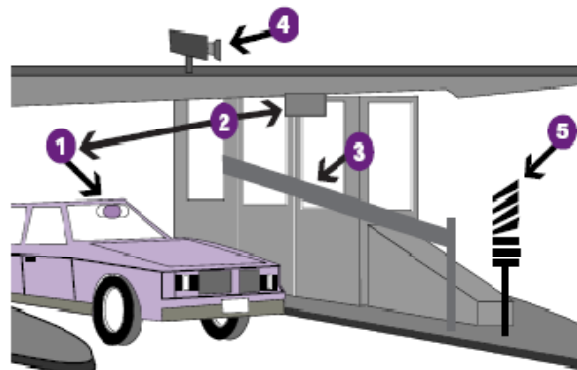
E-ZPass is an electronic toll collection system which uses a transponder to record and deduct toll costs from prepaid accounts as drivers pass through the toll lanes. The E-ZPass program allows for one

E-ZPass account to be used on toll roads in the Northeast area (Maine, New Hampshire, Massachusetts, New York, New Jersey, Pennsylvania, Delaware, Maryland, West Virginia, and Virginia) and parts of the Midwest (Illinois and Indiana).

Figure 23: E-ZPass Operations

How Your Tag Works

- ➊ As you pass through the *E-ZPass* facility at the posted speed limit, your *E-ZPass tag* is read.
- ➋ In an instant, the tag information is read by an *antenna* in the *E-ZPass* facility and the proper charge is deducted from your *E-ZPass* account.
- ➌ At some facilities, there are *gates* that will go up when a valid tag is read.
- ➍ *Video enforcement systems* are in place to identify toll evaders.
- ➎ A *traffic signal and/or message* is immediately displayed to you just beyond the *E-ZPass* facility.



Source: E-ZPass New Jersey Customer Service (2007)

There are two types of accounts: individual and business. Individual accounts may have up to four tags per account and are for cars, vans, pickup trucks, motorcycles and RVs. The business account applies to tractor trailers, auto transporters, pickup/other trucks, buses, vans, cars, and motorcycles and may have an unlimited amount of tags per account. The E-ZPass also allows drivers to receive an automatic discount when using the E-ZPass lanes compared to general toll payment.

The New Jersey Turnpike (NJTPK) is a 148-mile toll road with 29 interchanges and is one of the most densely traveled roadways in the United States (700,000+ vehicles/day). There are 187 E-ZPass toll lanes operating on the turnpike. 92% of the NJTPK revenue is derived from tolls, 35% of which is from out-of-state traffic. The toll is determined by time-of-day pricing program which encourages peak-period commuters to alter their travel times to off-peak times to reduce congestion.

The E-ZPass program on the NJTPK was implemented in two stages. Stage 1 was implemented in 2000 and introduced the E-ZPass program's time-of-day pricing to the Turnpike. Stage 2 occurred in 2003 and increased the toll levels for each time period and each vehicle type (5% for E-ZPass off-peak, 10% for E-ZPass peak, and 17% for cash payers).

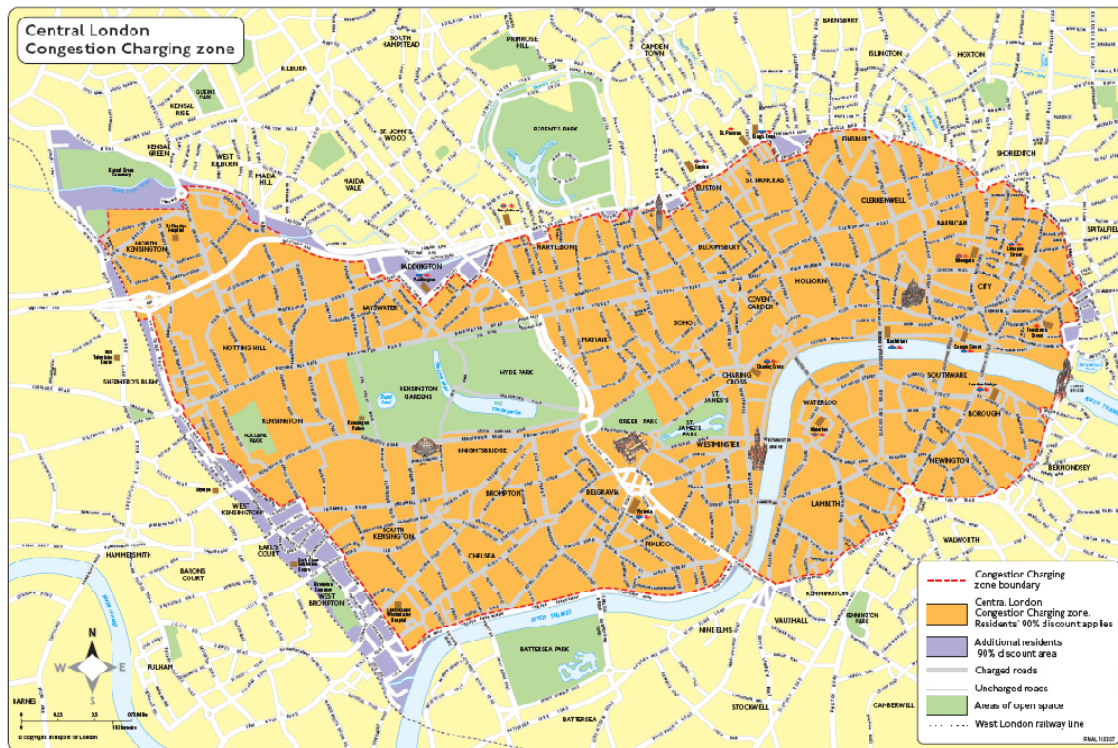
Despite the implementation of the toll program, there is a continual increasing trend in annual traffic, suggesting that time-of-day pricing does not have an impact on the increasing traffic congestion on the NJTPK. Also, the increase in toll price from Stage 1 to Stage 2 pricing and the differences between peak and off-peak periods were not substantial enough to have a statistically significant impact on NJTPK traffic (Ozbay, Yazman-Tuzel, and Holguín-Veras, 2006).

Outside the United States

London

Implemented in February 2003, the Central London Congestion Charging program serves the dual purpose of mitigating the congestion on the streets of London and generating additional revenue for the transit system. The congestion charging zone covers a 21-square kilometers area of inner London, and the charge (currently set at £8 [\$16.17], up from £5 per day in the beginning), applies from 7 a.m. to 6:00 p.m. (originally 7 a.m.–6:30 p.m.) on weekdays, excluding holidays (Transport for London, 2007). Taxis, alternative fuel vehicles, motorcycles, buses and emergency vehicles, among others, are exempt from the charge. Residents of the Congestion Charging zone only pay 10% of the full fee. For vehicles that are simply passing through, there are a number of routes that allow drivers to cross the zone during charging hours without paying (Litman, 2006).

Figure 24: Congestion Charging Zone (orange and purple areas), London, after western extension



Source: Transport for London (2007)

The geography of Central London was very well suited to pricing implementation. The street network at the core has not changed much since the medieval ages. Heavy travel demand resulting in severe congestion, and a wide variety of other transportation choices available (walking, taxi, bus and subway services) have created optimal conditions for adoption of congestion pricing. (Litman, 2006)

The system has experienced several changes since the implementation. The charge amount was increased from £5 (then \$8.72) to £8 (then \$13.95) in July of 2005 (Transport for London, 2006). On February 19, 2007, the Congestion Charging zone was extended to the west, and the charge hours were shortened by half an hour, to 7:00 a.m.–6:00 p.m. The cost of implementing the western expansion was £118 million (Transport for London, 2006).

Figure 25: Congestion Charging Cameras, London



Source: Wiss (2006)

The technology enabling congestion charging is based on video imaging and license-plate recognition. More than 200 cameras are used to capture vehicle registration plates at the entry point and store the vehicle information in a database until it can be matched to a payment. Strict enforcement and monitoring are necessary to ensure the effectiveness of the program (Turner, 2003). Non-payment rates were high during the first few weeks, probably due to driver confusion and vehicle plate number recognition errors. It is of interest that the payment methods preferred by the drivers are technology-intensive: increasingly, drivers pay the congestion charges by mobile phone text message (Litman 2006). In the future, using RFID transponders for an automatic payment by some of the drivers is a possibility.

In addition to cellular text messaging, motorists can pay the Central London Congestion Zone charge through payment machines located in the area, over the Internet, and at select retail outlets. Weekly, monthly and annual passes with a 15% discount are also available. Motorists that have not paid the charge by the end of the next business day are assessed a £80 fine, reduced to £40 if paid within two weeks, and increased to £120 if not paid within a month (Litman, 2006).

According to Litman (2006), about one million people enter the Central London District every day. Prior to congestion pricing, 12% of them would use private cars for the trip. Within a few months of congestion pricing introduction, the number of private vehicle drivers declined to 10% of the total number of people entering the zone. Approximately 110,000 motorists a day pay the congestion charge (98,000 individual drivers and 12,000 fleet vehicles). After six months of operation, 60,000 cars fewer per day were entering the congestion charging zone, and 110,000 persons per day were paying the congestion charge (Litman, 2006). According to Turner (2003), travel time to, from and across the priced zone were down by 14%, while the time spent moving at below 10 kilometers per hour had decreased by 25%. The express bus

routes serving the congestion zone have decreased the waiting time by 33%, and revenues for 2003 and 2004 were projected at £68 million. The annual net benefits, apart from the toll revenues, were forecast to be £50 million, and included time savings, fuel savings and benefits from transport reliability. The mayor has directed toll revenues for investment in public transport (Turner, 2003).

As of March 2006, net revenues of £303 million have been generated, excluding the implementation costs of £162 million (covered from Transport for London's General Fund; see Table 5, below). A further £620m was projected to be raised over the next four financial years. The revenues are being directed towards bus network improvements; extending accessibility improvements; interchange improvements to aid the integration of the transport network; contributing to the costs of developing possible tram or segregated bus schemes; safety and security improvements; accelerating road and bridge maintenance programs; restructuring fares on public transport; increasing late night public transport; improvements to the walking and cycling environment and other specified goals (Transport for London, 2006).

Table 5: Net Proceeds from London Congestion Charge, April 2002–March 2006

	£ millions rounded, audited					unaudited	
	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	Total
Total Operating Expenses	0	0	17	93	90	88	289
Charge Income	0	0	18	116	117	144	395
Enforcement Income	0	0	1	55	75	66	197
Total Income	0	0	19	171	192	210	592
Net revenues	0	0	2	78	102	122	303
Net proceeds	<i>(See below)</i>						

Source: Transport for London (2006)

Although very successful, the congestion pricing scheme has several drawbacks. The charge is not time-variable or location-variable. The transit system is somewhat crowded and requires further investment to support an additional influx of customers. The charge system has fairly high overhead costs. As indicated in Table 6, below, the annualized start-up and operating costs of running the Central London Congestion Charging program take up more than half of the revenue collected.

Table 6: Projected Costs and Revenues, London Congestion Charging Zone, 2000–2008

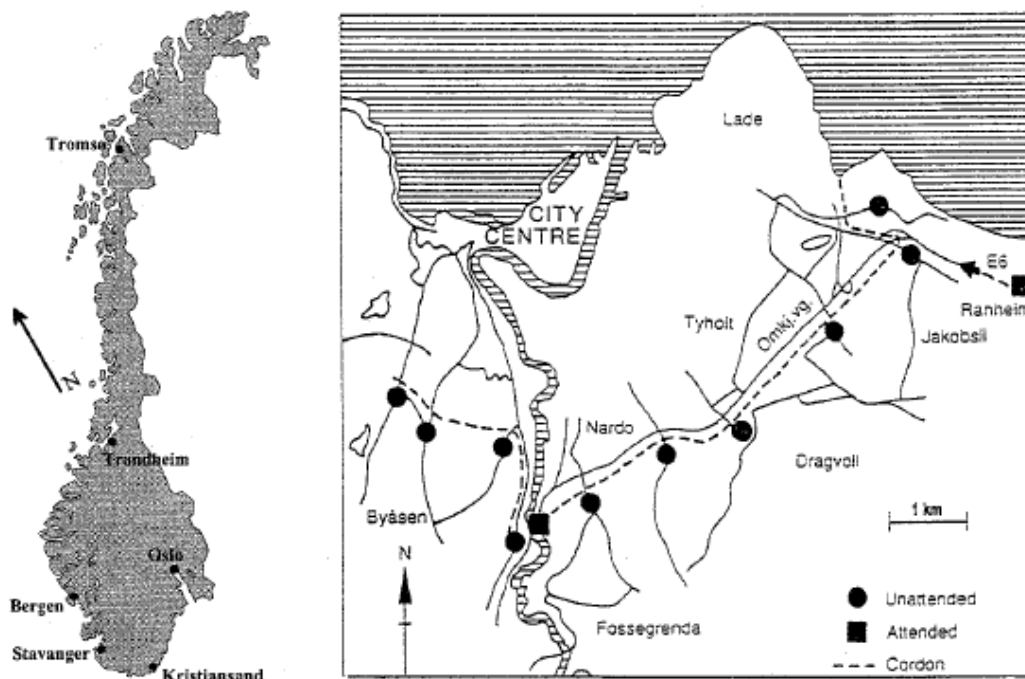
	Total (NPV)	Per Operating Year
Start up costs	£180M	£36M
Operating costs	£320M	£64M
<i>Total Cost</i>	<i>£500M</i>	<i>£100M</i>
Charge revenues	£690M	£138M
Penalty revenues	£110M	£22M
<i>Total Annualized Revenue</i>	<i>£800M</i>	<i>£160M</i>

Source: Litman (2006)

Political considerations play an important role when dealing with a wide-reaching congestion-pricing scenario. In 2000, the political system of London was restructured to give the elected Mayor new powers to manage the city's transport system and raise taxes to fund transport improvements. Ken Livingstone, who won the election, ran with a platform that included congestion pricing implementation, with revenues to be used for public transit improvements (Litman, 2006). In the United States, it is not clear whether the constituency of major cities will be as receptive to congestion pricing as the citizens of London, although New York might be better suited to such a congestion pricing scheme than most.

Trondheim, Norway

Figure 26: Toll Ring in Trondheim, Norway



Source: Amdal (2003)

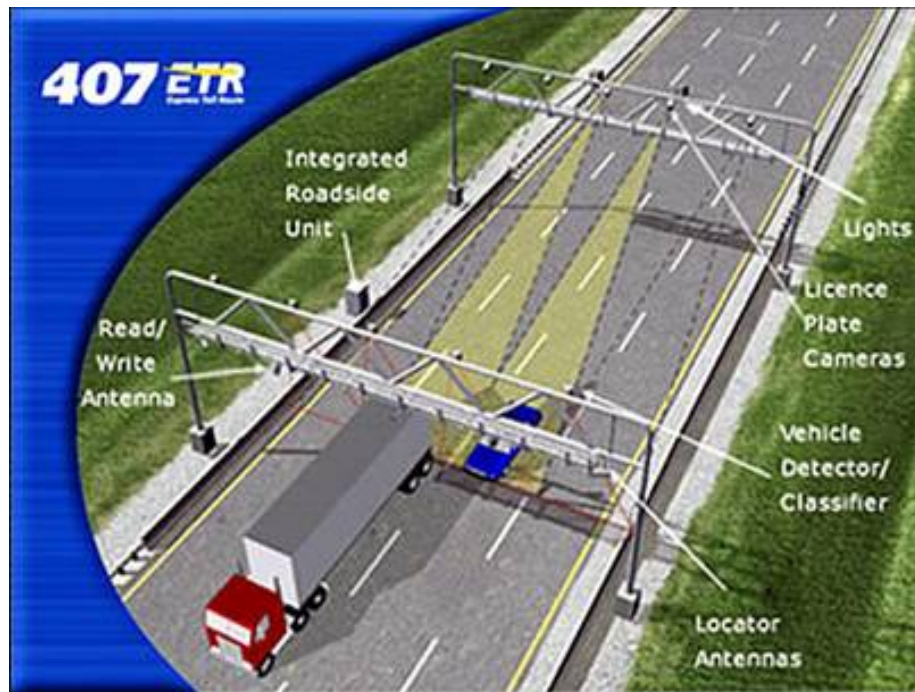
Trondheim, Norway is a city of about 140,000 inhabitants, with about 60% of the population living in the center of the city. In 1991 the city officials implemented an electronically operated cordon pricing system. The tolls are slightly higher during the morning peak hours, and are not assessed after 5:00 p.m. and during the weekends. There are no monthly passes, and the motorists are charged a toll for each entry (except when making repeated trips within the same hour, or after 75 crossings per month for cars with a special tag). The regular toll is 12 Norwegian Kroner (Nkr), or about \$2.07, which is 10% of the average hourly earnings for a Norwegian blue-collar worker. Heavy vehicles (over 7700 lbs, or 3500 kg) are charged double price. With the implementation of the Toll Ring, there was a 10% decrease in traffic both during the peak and non-peak charge period. Traffic increase in the evenings and on weekends was a little over 8% (Langmyhr 1999).

The Trondheim Toll Ring Project was well marketed before the opening. Today about 95% of the motorists entering the city center use the electronic payment system. The current revenues, around 150 million Nkr annually, are used to finance new roads, improved public transit and new pedestrian and bicycling facilities. In the first year after opening, weekday bus travel increased by 7%.

In 1998 the system was adjusted to cover more traffic in the urban area. The city was divided into six sectors, and vehicles crossing from one sector into another were required to pay toll. As a result, the traffic situation in the city center became significantly less congested than it had been ten years earlier. More recently, the Toll Ring was expanded again, with additions including six new charging points and an increase in the base price. The current system is estimated to produce about 200 million Nkr (\$34 million) per year of toll revenue, with operating costs of 17 million Nkr per year (less than 10% of revenue). Resulting inflow of revenue was sufficient to finance the latest round of investments in Trondheim's surface transportation infrastructure in 2005 (Amdal, 2003).

In 2001, Trondheim introduced a new toll charging technology called AutoPASS, with the goal of ensuring interoperability between the toll system in Trondheim and other Norwegian cities. Norway is supporting AutoPASS as a basis for standardization in Europe for electronic fee collection systems. As of 2003, drivers in South Trondelag County are able to use a common payment card, called the t:kort, for almost all the services in public transport (Porter, Kim et al., 2004). Overall, the system has been a success, although continuous challenges and improvements are to be expected. The issue of interoperability in toll paying technology between various jurisdictions is becoming more apparent in Europe, as it likely soon will in the U.S.

Figure 27: 407 ETR Open Road Tolling System



Source: Road Traffic Technology (2007)

Toronto's 407 Express Toll Route (ETR) is the world's first "open-road" (no cash tollbooths), all-electronic highway. Developed by Raytheon Systems Company and in operation since 1997, this electronic tolling system incorporates infrared and video technology to monitor vehicle usage and automatic toll collection.

407 ETR stretches over 67 miles (108 km) across the north side of the Greater Toronto area. The project was built in stages, with the first 36 km opened in 1997, and the final section completed in 2001 (Road Traffic Technology, 2007).

The toll route is equipped to collect tolls from transponder-equipped vehicles, as well as cash customers, without using toll plazas. Overhead tolling gantries record transponder-equipped vehicles as they enter and exit the facility (see Figure 27). Tolls vary by vehicle class and distance traveled. Heavy vehicles, over 5 tons (4500 kg) are required to carry a transponder that charges a special heavy vehicle rate (407 Express Toll Route) .

Close to 30% of the vehicles using the facility are not equipped with transponders. The license plate numbers of those vehicles are recorded electronically, and a bill is sent to the owner in the mail (such a toll is called a V-Toll). An additional charge applies for V-Tolls. Thanks to the agreement with neighboring Canadian provinces and some of the states in the U.S., drivers outside of the region can receive a bill in

the mail. Local vehicle owners with outstanding accounts who fail to pay their bill have their information sent to the Registrar of Motor Vehicles, where renewal of vehicle registration can be denied until all tolls are paid (Cothron, Skowronek et al., 2003).

A License Plate Recognition system identifies about 80% of the vehicles correctly. Digital images of the remaining 20 percent are checked by human eyes. About 6% remain unbilled as a result of an inability to read the license plate number, or the Ontario government's not having an extradition agreement with the vehicle owner's home state (Cothron, Skowronek et al., 2003). In 2005, over 100 million trips were processed with an accuracy rate of 99.9% (407 Express Toll Route).

I-407 has dedicated safety vehicles that patrol it seven days a week. In addition, the Ontario Provincial Police (OPP) and Ministry of Transportation enforcement officers also patrol I-407. While toll collection and enforcement is an automated process, traffic offenses such as speeding are enforced by OPP (Cothron, Skowronek et al. 2003).

Even though this system has been quite successful, it remains to be seen whether the currently possible accuracy rate is acceptable for implementation of future similar projects in the U.S. (such as on Toll Highway 101 in Tampa, Florida).

Conclusions

Bedeveled by congestion, cities around the world are increasingly experimenting with tolling via newly introduced technologies, to increase the cost of entering or traversing the city via car. This has given rise to the congestion-charging cordons in Trondheim, Singapore, and London, which have in turn inspired the proposed scheme in Manhattan. The Utah, E-407, and EZPASS systems, by contrast, are aimed at facilitating traffic flows on highways. This gives some idea of how congestion pricing can be used by different agencies to address different aims.

Of the six different congestion-pricing projects featured in this section, only two use variable pricing. This may be because variable pricing introduces a new element of potential confusion and uncertainty to users, especially users not previously familiar with toll facilities or electronic payment. In the long run, it might be easier to begin a congestion-pricing program with a set toll and later, if desired, convert it to a variable toll.

Conclusions

It is only in the last few years that advances in technology have made congestion pricing, especially variable pricing, possible. The increased interest in congestion pricing means that further refinements in existing technology may be available to new facilities opened within the next decade. There are now more options than ever for creating, managing, operating, and refining a congestion-pricing project. The five case studies, which opened between 1995 and 2006, are all still in operation, and while they have not escaped criticism, they have generated positive feedback, especially in the case of the MnPASS and I-15 Express Lanes facilities.

This is not to suggest that implementing a congestion-pricing project can or will be easy for other state departments of transportation. The public remains skeptical of congestion pricing. Moreover, the less exposure a person has had to electronic tolling mechanisms, congestion pricing, or variable pricing, the more likely he or she is to dismiss it as a form of congestion mitigation or revenue generation; and for all the advances of the five case studies, those facilities have been used by only a tiny fraction of the American driving population. A belief that the freeway capacity is “already paid for” will increase hostility to the proposed project unless the proposing body has a clear purpose for the generated revenue. Even then, as King, Melville and Shoup (2007) have pointed out, some members of the public will have more costs than benefits. Thus supporters of a new congestion-pricing project should be prepared for political opposition.

Finally, the concern that variably-priced lanes will allow the wealthy to buy their way out of congestion, further contributing to inequitable access to smoothly-flowing traffic, cannot be dismissed as resulting from public ignorance. The majority of equity-concerned surveys have suggested that managed lanes are used by both high- and low-income users, although the Houston QuickRide survey data (Burris and Hannay, 2003) suggests that users might have, on average, higher incomes than non-users. There may be a difference in access to transponders, or in trust in the enforcement system, between lower- and higher-income users.

The successful congestion-pricing projects featured in this review have been shaped over time by changes in policy and strategy. The SR-91 Express Lanes suffered a severe setback when public opinion turned against the private operator, and the MnPASS system was only implemented after several previous political failures. The I-15 Express Lanes and London congestion-pricing cordon may never have been implemented without the strong backing of key political figures (Jan Goldsmith and Ken Livingstone, respectively). In short, in order to overcome potential opposition and implement a congestion-pricing project that could ultimately benefit the region it serves, the backing body must be flexible, politically astute, able to communicate well with the public and future users, clear in its goals for the facility, open to new advances in technology, and confident in congestion pricing as a useful tool.

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Congestion Pricing Response

Section II: Expert Panel and Survey



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Congestion Pricing Response

Section II: Expert Panel and Survey

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Congestion Pricing Response

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Introduction

To enhance the information gathered from the literature review and case study sections of this project, a survey of transportation professionals who have implemented congestion pricing projects or programs was conducted. This task involved two parts: an intensive, two-day expert panel session, and telephone interviews with persons that have been involved at different levels of congestion pricing projects around the country.

These tasks facilitated the collection of information from states and regions that have studied and/or implemented congestion pricing strategies. For the first of these tasks, a group of five experts was brought to Atlanta for two days. During the panel sessions, the experts were asked to describe their experience with implementing congestion pricing in their region. Then, the experts were asked to provide practical advice as to how to implement value pricing initiatives such as congestion pricing in our region. These experts were public officials and transportation experts who have on-the-ground experience with implementing the congestion-pricing schemes and related technologies featured in the five case studies in the literature review chapter of this report.

Panel attendees included Mark Burris (Department of Civil Engineering, Texas A&M, representing Houston QuickRide, I-10, and US 290), Adeel Lari (Hubert H. Humphrey Institute of Public Affairs, University of Minnesota, representing MnPASS, I-394), Ellen Lee (Orange County Transportation Authority [OCTA], representing SR-91 express lanes), Stacey Stegman (Colorado DOT, representing I-25/US-36), and Heather Werdick (San Diego Association of Governments [SANDAG], representing I-15 express lanes).

The goal of this phase of the project was to gather information on:

- Public acceptance of congestion pricing, differentiating acceptance by user demographic segment and across various types of pricing strategies.
- Public response to congestion pricing in places where strategies have already been implemented.
- Techniques and policies (including public relations efforts) needed to implement congestion pricing.
- Technologies (existing and evolving) supportive of congestion pricing.
- Obstacles to congestion pricing.
- Outcomes of implementing congestion pricing.
- Effects of congestion pricing on land use.

Each of these topic areas was the focus of a separate session of the expert panel. The following chapter provides a summary of the expert panel discussions by project.

Specific Projects and Congestion Benefits

San Diego I-15

The San Diego I-15 toll facility was originally constructed as an 8-mile, reversible, 2-lane, center divider, dedicated toll facility. There are two entrances at the south end of the NB I-15 corridor and one entrance and exit at the north end of the facility. A single toll is paid electronically by users. The maximum toll on the facility is \$8, or the equivalent of \$1/mile. The system has been very successful and is often cited as a classic example of toll facility implementation on an existing right-of-way.*

The estimated toll revenues for the I-15 implementation were \$1.3 to \$2 million per year. In the first year of implementation, toll revenues were approximately \$1 million. Revenues grew to approximately \$2.5 million in 2003-2004. Recently, toll revenues have declined a bit due to construction activity and the opening of alternative routes (e.g., SR 56 connecting I-5 to I-15). The toll revenues are such that the facility is self sufficient. Operating costs are covered by operating revenues. It is important to note that the agency does not care if the facility is profitable. The agency is trying to increase system throughput and if the facility can cover its own costs, all the better.

Caltrans owns the I-15 facility and pays for maintenance. The San Diego Association of Governments (SANDAG) operates the facility and maintains RFID equipment (toll tag readers). Caltrans pays for the movement of the moveable barrier, and issues do arise regarding how much the system should pay to maintain traffic volume sensors and where these sensors should be located. In addition, there is a lot of debate regarding the funding of transit on the route. For example, two transit operators have an ongoing dispute over who should pay to maintain stations and who should operate routes that cross jurisdictions. Because multiple agencies and jurisdictions are involved, efforts need to be tightly coordinated.

The facility has been under construction for some time because the system is being significantly expanded. The new I-15 facility will be 4-lanes, 20 miles in length, with 7-8 entrances. The expanded facility will incorporate a moveable zipper barrier that will facilitate the provision of three lanes of travel in the peak direction. Both San Diego I-15 and the Riverside SR-91 use an interoperable toll tag technology that incorporates Title 21-based transponders manufactured by Sirit, Inc. California requires the use of

* The operators may have some detailed data on the traffic interaction effects at the entrance and exits of the toll facility (which will be of interest to this project).

interoperable toll tags throughout the state for toll collection. However, the future I-15 Expansion (mentioned later) is considering the use of new SmartCard technologies.

San Diego Association of Governments (SANDAG) handles the planning and operation of the facility. Right now, the region has the authority under State legislation to operate the I-15 tollway, plus two additional facilities. The region is considering implementing a similar system on the North-South I-5 (La Jolla to Oceanside), North-South I-805 (heading south from the La Jolla area), and/or the East-West State Route 52 from I-5 inland. If I-805 is selected as one of the two new HOT corridors, it will be outfitted with a 2-2 design with no zipper barrier. If SR-52 is selected, it will be two lanes, reversible only. A pricing study is currently underway. The pricing structure on I-15 is slated to employ a dynamic cent/mile strategy where pricing is based upon congestion level. The entire San Diego network is being modeled on the I-15 success.

Colorado I-25

The Denver I-25 HOT facility is a reversible, 7-mile system that begins in Downtown Denver. To date, the facility has been very successful. The system began as a 1994 HOV Facility and was selected as a Federal Value Pricing study effort. After 6 years of study and development, the facility opened in June 2006. In Colorado, the Legislature required that the system be interoperable with E-470 Toll Lane. The I-25 toll ranges from 50 cents to \$3.25, depending upon the time of day. A single location at the start of the system allows users to pay the toll via a transponder. All vehicles are required to be transponder-equipped. From an operations standpoint, Colorado experience has indicated that planners and engineers need to watch out for congestion that can occur on arterials at facility exit points.

The transit agency was skeptical at first about implementing the I-25 toll facility. However, policymakers required the toll be set at a minimum \$3.25 during the peak so that the tollway would not compete on a price basis with the Express Bus Fare. The Colorado DOT and the transit agency share revenues and \$200k went to the transit agency as soon as the funding was available. Sixty buses now operate on the corridor and these buses provide system performance data (travel times). Approximately 10-20% of vehicles using the system are organized carpools. In Colorado, \$2.1 million was generated in the first year of operations, which significantly exceeded the \$800k revenue expectation, and significantly exceeded the actual \$1 million operating cost. This is the only project where revenues currently exceed operating costs.

Colorado did not have any traffic counts before implementing the project, so any before and after comparisons are not really valid. Some publications indicate increase in HOV activity associated with the project, but the expert doubts this. Colorado is getting ready to do a study to examine the impacts of the facility.

In planning the system, the legislation was described as a “hodge-podge,” and the legislation required multiple revisions with respect to system implementation. One recent court case was filed by a carpooler who claimed that he should not have to pay a toll. The solution to this current problem was to clearly stipulate in the law that HOT facilities are different than HOV facilities, to define each type of facility, and clarify in the law which users qualify for fare exemptions.

All of the back office support and violation enforcement is contracted out, in part because the billing system was already in existence. After completing a recent traffic revenue and feasibility study, Colorado is now considering the implementation of pricing on 12 new corridors. Each candidate corridor is being evaluated in more detail. It is important to note that the Colorado system does state as one of its goals the raising of surplus revenues for use elsewhere in the system.

In Colorado, the biggest issue was the selection of access and egress locations due to potential business impacts. Each city wants access to the system. However, analyses are required to justify the costs of adding an entry point, given the number of trips that would be generated by the additional entrance. The safety of slip ramps was also a major concern. Finally, there was much concern at the local level about the potential local congestion impacts at the ends of the systems. A local traffic impact study should be a major element of the project as local residents (and their elected officials) are very concerned about how a new system will affect their local traffic.

Orange County SR-91

The cost of housing in Orange County California is very high, and commuters use the SR-91 corridor to commute from more affordable housing in Riverside, CA to jobs in Orange County. California SR-91 includes a tolled 4-lane facility in the median, separated from the main flow by lane channelizers.[†] The soft barrier lane channelization system consumes approximately 1.5 to 2.0 additional feet compared to a normal lane. The corridor handles approximately 280,000 AADT, with approximately 40,000 using the express lanes. The express facility includes only one entrance and one exit. The toll ranges from \$1.20 to \$9.50 per trip by time of day. There are no dynamic tolls. All SR-91 users must have a transponder.

[†] The soft barrier system costs approximately \$35 per pylon and the pylons are spaced every 8-10 feet along the dividing line. It is reasonable to assume that on the average each pylon is replaced one time per year. Caltrans handles these maintenance costs, so the costs are outside of the maintenance costs borne by the tollway authority. Such costs should be factored into any analysis for the Atlanta region. Interestingly, for the proposed systems in California, Caltrans does not want to put in channelizers; Caltrans is advocating double striped lines instead and is currently investigating cost tradeoffs associated with increasing the number of tag readers to improve enforcement (UC Berkeley is undertaking a study).

Houston HOT Lanes

The Houston system is a relatively small program that includes the Katy Freeway and Northwest Freeway. These facilities include single-lane reversible HOV lanes. The system is a single-lane, grade separated, reversible system serving transit and park and ride systems. The Katy Freeway previously operated as a 2-person carpool lane. It started out as a busway, then gradually increased access to allow vanpools and then moved to carpool 2+. When the lane was converted to a 3-person carpool lane, demand declined significantly. Two-person carpools are now allowed to pay for access to the facility using transponder technology.

The Texas Department of Transportation (TXDOT) owns the facilities and Houston METRO operates the toll facility. Because the facility is owned and operated by different agencies with different goals, policy makers in the region have complained that METRO wants to move quickly. However, TXDOT wants to move slowly, to avoid public backlash associated with potential missteps. To date, TXDOT has prevailed and the region is in a go-slow approach mode focused in studying the potential impacts of pricing systems and mechanisms.

The Houston QuickRide system has a relatively small user base. More than 150 vehicles people/day are being billed by the system. However, there are many more vehicles using the system than this. Approximately 2 million people in Houston have transponders and lots of people are using the system, but the toll gantries do not capture their payments. The existing technology of the system is deficient because vehicles are using an older TransCore transponder technology and a very large number of the battery-powered active transponders being employed are no longer working. The Katy and Northwest systems were implemented “on-the-cheap” and almost no new technology was deployed. The system is designed for travel speed, not for toll collection. HECTRA operates separate toll systems that employ low cost sticker tags. Houston METRO is now shifting to the cheaper, passive, sticker tag system (\$6 per unit). When Katy Managed Lanes go online in late 2008, most of the tag reading problems will be resolved because everyone will be required to purchase new transponder tags. The passive transponder tag sticks to the windshield, but cannot currently be turned off or shielded in a bag (meaning that the tag cannot be switched off when a user is operating a toll-exempt carpool).

The region is looking forward to having fully integrated parking, transit, and HOT lane payment technologies. However, the implementation will require legislative changes, due to Title 21. Houston has 2 million tags, so switching to a new platform will create an issue.

A total of 2500 registered users pay the monthly maintenance fee of \$2.50 (\$75k per year). The small monthly service fee serves as a nominal revenue source but is viewed by the user community as a reasonable cost for participation. Texas undertook a recent trip survey of system users. They received

approximately 500-600 responses to the mail-out/mail-back survey sent to system users enrolled in the program. These survey results might provide useful input into the Atlanta design process if the data or results can be obtained from the sponsor.

The region is moving toward implementation of HOT Lanes on all HOV corridors. On the proposed two-lane systems, they face the problem of trying to split toll payers into one lane and carpoolers into the second lane. There are significant space issues associated with installing 2 lanes and retaining enough space to provide for enforcement pull-over activity.

Minnesota MnPASS System

The I-394 Radial Interstate runs east-west and provides commuters from the western suburbs of the Minneapolis-St. Paul metropolitan area with access to downtown Minneapolis. In 2005, the HOV lanes on I-394 were converted to HOT lanes. The MnPASS HOT system is 11 miles in length, with a three-mile reversible section and an eight-mile long diamond lane section. The two lanes in the reversible section are separated from the general lanes by concrete barriers, and operate inbound from 6 am to 9 am, and outbound from 3 pm to 6 pm. The 8-mile diamond lane section consists of one lane in each direction, with multiple entry points designated by dashed openings in a double-solid line. Snow removal is incompatible with soft barrier systems, so lane separation in the diamond section is handled with double-striped lines.[‡] Tolls on the facility vary by time of day (based on the level of congestion), as well as by distance traveled. The reversible lanes are priced at all times, and the diamond lane section is priced only from 6 am to 10 am and from 2 pm to 7 pm. The toll to single occupant vehicles is assessed electronically, via RFID communication between in-vehicle transponders and overhead gantries.

The MnPASS system employs read-write transponders provided by TransCore at a cost of approximately \$10 per tag. Approximately 1 million transponders are in the field. The system reads the RFID card and collects tolls from users only when their transponder system is activated. The MnPASS transponders are automatically activated when they are clicked into their windshield mount (the transponder issues a beep tone to indicate that it has been activated). The read-write capability of the technology allows the system to write data to the tag indicating that the current toll has been paid. This also allows remote inspection of the toll payment status by enforcement officers.[§] The corridor includes multiple tag readers for

[‡] MnPASS is exploring the use of a zipper barrier on an I-35 expansion facility being funded under the urban partnership program, which would allow two lanes of the three lane facility to operate in the peak direction.

[§] The active read-write system can be adapted into a remote enforcement system. The payment status data on the card can be read by a roadside enforcement system to trigger license plate capture for automated enforcement.

enforcement. The facility breaks even, in that toll revenues basically cover operating costs. This is not considered to be a revenue generating project, nor is revenue generation a goal of the project.

Double white lines are broken by dashes to demarcate entry and exit points. However, weaving violations across the solid lines are not prevalent. In fact, there has been a noted decrease in violation rates, which the Minnesota Department of Transportation (MnDOT) believes is most likely associated with the significantly increased enforcement efforts. The enforcement is performed by patrolling officers outfitted with mobile enforcement RFID tag readers. The fine for the 1st moving violation is \$143. Failure to pay a toll, weaving across the double-solid lines, and failure to have sufficient passengers when claiming to be a carpool are all considered moving violations. The moving violation status means that all three contribute “points” toward license suspension and insurance rates.

The MnPASS system is recognized as the most successful HOT corridor implementation in the nation. MnDOT has documented a of 5-7% congestion reduction on the general purpose lanes for 11 routes. Safety improvements have also been documented in the form of reduced speed differentials between lanes and associated with congestion queues. To date, analyses indicate that crash rates on the corridor have declined and effective lane capacity has increased, as predicted. Associated ramp metering is predominantly being used to address crashes and not to optimize traffic flow on the freeway. The University of Minnesota has access to detailed traffic data, which can be used to assess some of the results. In addition, 600 longitudinal household surveys were conducted and, in conjunction with focus group data, serve as the basis for conclusions regarding public acceptance. The DOT developed a full traffic simulation for the corridor that was very helpful in both the technical design evaluation process as well during the public hearing process.

General Operations Recommendations

- Implement congestion pricing
 - The panel members all indicated that their respective pricing systems are working well and are effective in reducing traffic congestion (although the Houston systems are really considered small scale operations at present)
- Don't worry about whether the facility is making money
 - Keep in mind that revenues from HOT and toll systems “are a drop in the bucket” with respect to the overall costs of constructing a corridor
 - The revenue focus in most areas is on covering marginal costs
 - Most regions do not care whether any excess funds are generated because the goal is to reduce congestion at a cost significantly lower than building new capacity
- Incorporate a monthly fee for participating in a priced lane system

- The fee has been found to be a reasonable approach to raising general operating revenues enough to pay for the administrative overhead of operations (though the revenues are generally small)
- Require that all vehicles using the HOT or toll facility be equipped with transponders
 - A variety of transponder technologies are available for deployment and all can be implemented at reasonable cost
 - Colorado is even requiring the exempt clean vehicles to be transponder equipped so that impacts can be tracked
- Consider the use of new, less expensive, battery-less paper tag transponder technologies
 - However, Houston has indicated that even though they are switching to the lower cost paper tags, the region is looking forward to deploying smart cards to fully integrated parking, transit, and HOT lane payment technologies
- Consider moving directly to smart card technologies to fully integrate payment parking, transit, and tolling systems throughout the region
 - If economically feasible, the region can skip deployment of the battery-less technologies and leap frog ahead of other regions
- Consider using higher-end interactive transponder systems, such as the system deployed by MnPASS
 - The transponder system deployed by MnPASS allow a write function to the RFID and is preferable from a data collection and enforcement standpoint (recommended by MnPASS)
- Ensure that technologies are interoperable throughout the state
 - Consider ensuring that technologies are interoperable throughout the greater southeastern region
- Rather than simply adopting a transponder technology already deployed elsewhere, perform a full 20-year life-cycle cost analysis of hardware tradeoffs before selecting a technology
 - Economic analyses should include the cost of transponder replacement, if battery-powered RFID technology is deployed. The Houston RFID tags are no longer functional, due to the age of the battery systems, which must be refreshed every five years
- Develop a complete micro-simulation model for each pricing corridor, in its entirety
 - Use of a calibrated simulation model is highly recommended for: evaluating alternative designs and predicting system performance response to operational changes
 - More importantly, simulation modeling results and graphic presentations are needed for use in public meetings in to describe system performance and benefits
- Conduct local traffic impact studies

- Traffic impact studies should be a major element of the project to assure local residents that the system will not impact local traffic at the endpoints
- Use a simulation model to assess potential impacts that each priced facility will have on the traffic volumes of non-priced connecting freeways
- Ensure that subsequent system improvements on parallel facilities do not affect the demand for and revenues from HOT facilities after they are implemented
 - In the case of I-85, implementation of a BRT on Buford Highway could potentially affect I-85 HOT revenues, so both projects should be analyzed concurrently
- Ensure that there is sufficient monitoring in place to assess the benefits of the implemented systems (providing data to support the implementation of new facilities)
 - ATMS machine vision system should monitor before and after traffic volumes, densities, and speeds to document congestion reduction benefits
 - Longitudinal household surveys should be conducted of participants (tollway users, general purpose lane users, express bus riders, and telecommuters) before and after implementation
 - Traffic safety studies should examine before and after crash rates
- Perform an engineering operations review of the MnPASS system
 - Atlanta design and operations engineers should review how the MnPASS system employs ramp meters within the MnPASS system and determine whether the same linkages should be developed in the Atlanta region

Political Support and Public Relations

All of the experts reported that obtaining state agency support for their projects was easy. "All politics is local, state support is easy." As stakeholders, the TMAs in all of these regions were on-board with the HOT/Toll facility development from the start. They are advocates and do not need to be convinced of the benefits. It is the lack of local knowledge, even in areas where pricing has already been implemented, that is the major issue of concern with respect to public outreach. For example, in San Diego, many commuters on the candidate I-5 corridor that were interviewed were not even aware that the I-15 system is in operation. Obtaining local political support and conducting local public outreach is critical to the success of pricing projects.

Minnesota DOT experienced what they considered to be a major failure at getting the toll lanes off the ground in 1997. The major lesson learned was that they needed to develop political support along the priced corridor. After 1997, MNDOT formed an advisory committee chaired by State senators. Pricing would now be explored as a concept. The Humphrey Institute managed the analysis (collection of focus group data, vehicle activity data, etc.) supported by consultants. The advisory committee was also

composed of members of the environmental coalition, AAA, the public, etc. Officials visited to San Diego to learn about the success of the I-15 corridor. After a 2-3 year process, the concept of HOT lanes reached a level of support that was deemed adequate to move forward. The advisory group then went to the Legislature and asked for enabling legislation for the HOT Lanes concept (proactive), even though the DOT was reluctant to move forward with HOT lanes. The Legislature decided in that process to dedicate 50% of revenues to transit, and 50% to the corridor. After the next election, and subsequent Executive Branch turnover, the new DOT took up the charge. A new advisory committee was formed to undertake specific corridor analysis (everything from design, striping, signage, etc.).

Colorado and California held standard public meetings hosted by the planning agencies, as if the pricing projects were routine projects. In contrast, the MnPASS public outreach efforts were quite extensive, because the region had failed to implement their original proposals in years past. When the press reported that the region was again considering the implementation of a HOT Lane proposal, they received 7000-8000 calls asking about when a public hearing would be held. In Minnesota, advisory committees were formed that were composed of both elected officials and public citizens (future users). Local support (i.e., along the pricing corridor) for the initiative was found to be the real key to success in Minnesota. By addressing local government concerns about project impacts first (primarily the expected impacts on local roads) a cadre of local experts will arise from the consultation process. These local experts can be brought in to the local public process as project advocates. In Minnesota, rather than DOT coming in to meetings and forcing the issue, public objections to the proposed system were addressed by local representatives, with DOT back-up. Key state senators or legislators, county commissioners, or city officials are examples of leaders who have the potential to be supporters and subsequent opinion leaders for such projects. Finding local champions for the projects is a critical element of success. One panel member indicated that "You can never have too much support at the local level."

None of the regions reported opposition to the pricing systems being mounted by any specific interest groups or coalitions. Some local transit agencies did express some outrage at first which was mitigated through revenue sharing and toll policies. HOV users did generally support the HOT concept, but at a lower level since there would be tolls in place for HOV-2 where no tolls previously existed. Upper and lower income groups support the concept in the focus groups. Some middle-class activists in the \$50k to \$75k income range expressed objections, but from two very different perspectives: 1) one middle-income group did not support the concept of pricing at all (objection by principle), and 2) one middle-income group did not support pricing because they perceived there would be negative impacts on lower income individuals.

Although the low income population uses the toll lanes less frequently than higher income populations (confirmed by surveys and panels), the low income population uses the system: 1) to keep important appointments, 2) to reach multiple jobsites, 3) when they are late to meetings, 4) when the toll costs are less than late arrival penalties for daycare, and 5) under other conditions where a need is perceived. None of the HOT systems have implemented any low income adjustments to tolls as there has been no expressed need for such adjustments. San Diego framed their system as providing choice: 1) you can choose to use the system, 2) you can choose not to use the system, or 3) you can choose to use the improved transit service that comes along with the system.

One of the main concerns expressed in public hearings was whether the revenues would be returned to the corridors from which they were generated.

- In Colorado, all funds must be used within the region.
- In Minnesota, \$2.5 million was returned to the corridor in the form of new auxiliary lane engineering.
- Both MnDOT and TxDOT have a 50/50 revenue split with the express transit operators on the corridor.
- San Diego is operating on their third MOU at this point, and the MOU stipulates that there shall be a set split of revenue between highway and transit (which has received \$7 million so far).

In Colorado, the agency determined quickly that focusing on the revenue source is a mistake. Such a focus gives the public the impression that if the region already had funding available to build more unpriced lanes, the region would build them and would not choose to build toll lanes. The key here is that priced lanes operate much more efficiently and that the construction of the lanes makes more sense than the construction of unpriced lanes. Revenue generation is not the focus. The various agencies are focusing instead on demonstrating that their managed lanes handle more people (reporting is not necessarily focused on whether the system handles more cars). This appears to have been received positively by the public. All of the regions expressed that HOT implementation will be significantly easier to implement when new capacity is constructed at the same time that pricing is implemented. One panel member stated that “Texas is pretty pro-toll, but takeaways are a real problem.”

A consistent message is not critical to the success of HOT lane and toll projects. Different messages are needed for different constituencies (commuters, non-commuters, politicians), delivery fleets (UPS), truckers, environmentalists, and even lobbyists. One panel member commented that the region should not “let AAA get away with saying that they speak for their membership, since most members are simply buying emergency services.” Having the support of delivery companies in public meetings can be very helpful.

Safety and security issues appear to be very minor public concerns with respect to implementing priced systems. For the most part, the facilities do not look, feel, or operate significantly differently from regular facilities.

Privacy issues are seen as being less important than portrayed in the press. One panel member commented that “Privacy is a red herring.” In Florida, users of the bridge tolling systems could sign up for an anonymous account. Because so few users opted-in to the use of anonymous toll tags in Florida, none of the major HOT systems have implemented this option. Nevertheless, protection of privacy needs to be addressed in system implementation, even if anonymous accounts are not implemented.

Colorado outreach has also focuses on showing the public that the HOT lane is carrying more people/lane/hr than the general purpose lanes. The panel members indicated that it is “important to demonstrate the benefits of the managed lanes with simulation modeling.” However, panel members also indicated that as far as the public is concerned, if a facility “looks empty, it is empty.” Third party credibility is helpful. In Washington State, Tyler Duval (Assistant secretary of the DOT) spoke at the regional transportation summit. Duval sparked the interest of the mayors. Universities and public interest groups can also provide documentation of expected benefits for use in public hearings.

All of the experts agreed that HOT lane implementation has waited for years to be implemented due to a lack of political champions and lack of available funding. The availability of funding from the Value Pricing and ITS programs stimulated their states’ interest in pricing mechanisms. In fact, local mayors actually came forward to request that their state agencies request funding under the recent Urban Partnership Program. Federal funding definitely captured their interests. “The more successful examples we have, the easier it will be to continue down this road.” As an aside, panelists indicated that agencies can be their own worst advocates for a system when they behave “like bulls in a china shop.” Local advocates for the systems are considered by the panel to be the key to success. Agencies should think carefully about who should be their project champions in the press and in meetings because the public may not respond well to a traditional agency-driven media campaign.

Political Issues Recommendations:

- Agencies should consider submitting applications for federal funding assistance for HOT lane implementation
 - Federal funding lessens the need for state funds and helps overcome initial public objections to implementing the first project
- Public outreach should focus on the fact that the HOT lanes ensure that the revenues being spent on the system are returned directly to the corridor

- HOT lanes are not a major revenue source and they are barely able to pay for themselves, so the focus is on covering the costs on the corridor
- It is important to start “messaging” about the proposed implementation early in the process
 - The user community understands that the implementation of user fees lessens the reliance on gas taxes
 - A single consistent message is not critical to the success of HOT lane and toll projects; develop different messages for different stakeholders
 - HOT lanes are not a major revenue source and are barely able to pay for themselves, so the major focus should be on the fact that the HOT lanes ensure that the revenues being spent on the system are returned directly to the corridor from which they are generated
- Outreach should also focus on showing the public that the HOT lane is carrying more people/lane/hr than the general purpose lanes
 - The public needs to understand that freeways carry more vehicles at 35mph than at 15mph and 60 mph (simulation modeling and graphic outputs may help)
- One of the most important messages is that the HOT system provides choice for the users
 - Users can choose to pay and use the system
 - Users can choose not to pay and use the existing system
 - Users can choose to use the improved transit service that is paid for by the system
- Garner the support of delivery companies in public meetings
- Monitor for potential negative impacts on low income households, but do not be surprised if the impacts are not significant
 - Potential negative impacts of road pricing on low income households have not turned out to be as significant as issue as was originally envisioned in public policy papers
 - Focus groups and observation data have indicated that although the low income population uses the toll lanes less frequently than higher income populations, the low income population benefits significantly from the provision of the toll lanes
 - Low income populations are generally in favor of implementing HOT lanes because they have a need to use these lanes for specific types of trips and are willing to pay the costs to save time under certain conditions
- Do not consider the implementation of low-income toll adjustments
 - None of the HOT systems have implemented any low income adjustments to tolls as there has been no expressed need for such adjustments; hence, the Atlanta system does not need to provide low income toll adjustments
- Anonymous accounts for toll payments is not a necessary feature for implementation of HOT facilities

- The transportation agency should not necessarily be the 'face' for HOT or toll project implementation
 - It is important to ensure that the individuals carrying the project message to the user community are respected by and have some clout with the user community
- Finding local champions for the projects is a critical element of success
 - Elected or appointed local officials at the county or city level can serve as advocates for HOT lanes
 - A seminar for local government officials on the benefits of HOT lanes might be a good venue for developing local champions**

Outreach Programs

As indicated in the previous section, community representatives need to be involved early in the process of developing any HOT system. However, in addition to educating influential decision makers, it is also critical that regions implementing pricing strategies conduct public outreach campaigns. Such campaigns can include direct mail contact, interaction with stakeholders, and interaction with the print, radio, and television media.

To communicate with users, most of the regions have developed a newsletter (similar in format to those sent by water, gas, or electric utilities) that they send to their customers every month or quarter. This kind of outreach effort, however, only reaches existing customers. Additional public outreach efforts are recommended.

SR-91 users recently participated in a public opinion poll and the survey results will be reported soon. The majority of the SR-91 users want tolls going back into the corridor. Users indicated that they use the facility when they need to complete a fast trip and they clearly understand and support the tolls. Users know what would happen to travel times if the toll was eliminated. Recent San Diego surveys focused on how the region should spend revenues (public outreach is being conducted on proposed corridors). Again, the vast majority want the funds to be plowed back into the corridor from which the funds are generated. Survey and focus group results are available online.

Websites are a useful means of disseminating information about the toll systems. All of the systems have available online information describing their respective facilities. Both the Minnesota DOT and San Diego have video descriptions of their systems available on their websites. The panel recommended that in

** Minnesota County Commissioner Linda Koblick served as one of the major liaisons between the DOT and the public. She might be willing to come to Atlanta to speak at a local government meeting if invited.

addition to a frequently asked questions (FAQ) section that the web interface include a page for the public to submit questions that are answered by the implementation team.

Colorado conducted a branding and naming campaign for their new facility and concluded that they wasted \$50k in consulting time on branding. The focus groups essentially settled on the term Express Lanes as being easy to understand and a good description of the projects being implemented.

With respect to interacting with the press, the Florida toll bridge authority hired a marketing representative who went daily to talk to the press. The panel indicated that this was overkill. Nevertheless, the panel advised that certain interactions with the press are advisable. The panel recommended providing reporters with facts and issues to write about, before they talk to the “Man on the Street” and make up their own story based upon potentially biased or sensational input. Minnesota currently works directly with the staff of the regional newspaper’s Editorial Board to support any stories they are writing about the system. To date, the paper has always provided “pretty good support” for the projects. In Minnesota, the public information department has one dedicated staff member assigned to HOT Lanes. The staffer is educated on system operations and is relieved from handling routine public inquiries regarding ridesharing (or other issues handled by regular commuter outreach staff members). Furthermore, the state has contracted with the Humphrey Institute to provide a political/communication consultant who helps write articles, ghost-write editorials, etc. This contractor is essentially a lobbyist/outreach consultant and is always available to answer questions from the press. Houston’s projects are relatively small (they are still carpool lanes) and they receive very little press.

Internal education of engineers is also considered by panelists to be an important element of project success. Engineers have standard procedures, following prescribed formulas and design criteria in the AASHTO Green Book. However, in implementing HOT systems in space-constrained corridors, it is often a challenge to meet standard design criteria. The need for design flexibility and cooperation between state and local officials is often required to implement projects on constrained corridors.

Outreach Recommendations:

- The region should develop a relationship with the editorial board of the *Atlanta Journal Constitution* and educate the editor and reporters on the benefit of any proposed toll projects
- Similarly, the authority should develop positive relationships with the local radio and television stations (including CNN, which covers stories of national interest)
- Atlanta should consider hiring a communications contractor who will become immersed in the project (and can handle the technical and policy issues) and who will make himself/herself available on demand for press interviews and public meetings
- The Atlanta region should not bother to conduct a branding campaign

- Recent focus group findings from Colorado that indicate we should use the term “Atlanta Express Lanes”
- An Internet presence is absolutely necessary for the implementation of a toll project and the website should include:
 - A system overview (including a video)
 - Current operating conditions and toll status
 - Descriptions of project benefits
 - Answers to FAQs
 - An interactive page that allows users to submit questions to be answered by a technical/policy expert
- The tollway authority should prepare a monthly or quarterly newsletter for their customers, similar to newsletters routinely sent by utilities, that describes recent system activities and policies (as is done for SR-91)
- The tollway authority should conduct an annual customer satisfaction survey (as is done for SR-91)
- Outreach materials should focus on demonstrating that managed lanes handle more people than general purpose lanes
 - The panel agreed unanimously that this concept is received positively by the public
- Cooperation and coordination between State design engineers and FHWA staff is critical to ensuring that when any design specifications deviates from standard Green Book specifications that the design will be approved

System Enforcement

There are generally three types of HOV/HOT/Toll violations that can arise: 1) failure to pay a toll, 2) failure to meet required carpool occupancy levels, and 3) crossing into or out of priced lanes in illegal areas. Identifying violations of these types can be difficult, typically requiring the use of manual enforcement methods (where police are required to observe the violation, pursue the vehicle, pull the vehicle to the side of the road, and issue a ticket). Pursuit of violations is difficult and potentially hazardous for the enforcing officer who typically must leave his/her vehicle to issue a citation. The expert panel also concurred that vehicle pullovers on any system can cause problems in other lanes due to weaving. Finally, the enforcement process does not stop at ticket issuance. For enforcement actions to provide meaningful deterrent incentives, some action needs to be taken on the part of the court system (which is often not the case). Each jurisdiction has a unique enforcement program, treats violations differently, and has different interactions with the courts.

San Diego I-15

In San Diego, the current system violation rate is estimated to be somewhere between 5% and 15% (which is comparable to the current HOV violation rate in Atlanta). In San Diego, the carpool violation fine is \$341 for the first offense, and the fine increases with repeat violations. Physical enforcement on the I-15 in San Diego is handled by the California Highway Patrol (CHP). A CHP officer pulls the vehicle over, issue a citation, and testifies in court as to the details of the violation. There is a general sense that judges feel bombarded by this case load. San Diego is currently focusing their attention on the court system and trying to educate prosecutors and judges as to the importance of HOT enforcement. Their efforts are designed to reduce the number of cases that are dismissed during prosecution. Cases are dismissed when an officer does not appear in court, usually after one or more continuances have been issued. SANDAG is currently undertaking an enforcement study and is considering the use of an Administrative Law Judge to adjudicate cases.

Orange County SR-91

SR-91 manual enforcement is handled by the California Highway Patrol, just as it is on the San Diego I-15. Officers stationed in an enforcement booth watch for vehicle occupancy violations. CHP officers will pull vehicles over, issue a citation, and testify in court as to the details of the violation. Each year, SR-91 expenditures on enforcement are \$400,000 for one dedicated officer. Monthly enforcement meetings are held between Caltrans and the authority and monthly reports are prepared. When vehicles are moving at speeds of 75 mph, officers cannot adequately detect vehicle occupancy. As a result, approximately 35% of vehicles that are pulled-over for enforcement actually have 3 persons in them, where one or more were not observed by the officer prior to the stop.

The SR-91 toll facility also employs license plate capture along the corridor for toll evasion enforcement. A multi-stage enforcement process is implemented, where tollway authority acts as the first level of the court system to adjudicate violation notices. The tollway authority contacts toll violator by mail giving them the opportunity to pay the fine or contest the fine (paperwork is included for the driver to complete and return).^{††} Drivers who do not respond to the initial letter are issued a second notice. The California Motor Vehicle Code limits fines to \$100 for the 1st violation, \$250 for the 2nd violation, and \$500 for the 3rd violation. When the car in question is a rental car, the notice is sent to the company who forwards the notice to the driver. The rental company must respond to the authority and submit applicable paperwork for the referral (or be responsible for the fine). Drivers who fail to pay or file the required paperwork to request an appeal are referred to a collection agency (the agency contracts out this work). When an appeal is requested, an administrative hearing is conducted in which the driver meets with a 3rd party

^{††} It is interesting to note that San Diego does not have access to license plate database, while the enforcement team for the SR-91 has access to the database.

arbitrator. The arbitrator then makes the decisions as to whether the fine should be upheld. Drivers may appeal an unfavorable administrative decision by filing in superior court and appearing before a judge to plead their case.

Because the authority can only access California license plate data, there is no enforcement mechanism to pursue drivers of vehicles registered outside of California. In addition, some drivers are installing reflective plastic covers over their license plates that leave the plate visible to the eye but reflect the license plate reader flash such that the plate is obscured in the photograph. The SR-91 authority is exploring mechanisms to remedy these problems.

In Fiscal Year 2007, the SR-91 authority collected more than \$5,000,000 in penalties. The Franchise Tax Board (the California equivalent of the Georgia Department of Revenue) has the authority to recapture unpaid fines by state withholding of tax refunds, ensuring that fines are paid.

Colorado I-25

The operators of the I-25 facility contract with Colorado State Patrol to monitor HOV violations. The facility includes a couple of pull-off areas for officers to pull over vehicles for enforcement. License plate photo capture technology is employed for enforcement on the I-25 facility. A contractor has been hired to mail out and track the violations. A violator is sent two or three notices that state they were in violation of the toll payment requirement, that their plate was captured, and that they must pay the fine. The driver has the choice of paying the fine by mail or going to court to appeal the penalty. Given that goal of the Colorado system is not to raise revenues, enforcement penalty collection has been very forgiving. When toll authority staff members are called by violators who request that the fines be dropped, it is generally the case that the fines will be dismissed by the agency. Since the facility opened, 5744 violation notices have been issued; 3207 have been paid (about 56%) and the rest have been dismissed.

Colorado is pursuing the authority to use an Administrative Law Judge to adjudicate all enforcement cases in an effort to reduce the current problems associated with pursuing violations through the court system. This procedure would also allow fines to flow to Metro, rather than into state coffers.

Law enforcement and emergency vehicles are required to pay the toll on I-25. These vehicles are only exempted when they demonstrate that the travel is for emergency purposes. This includes all marked and unmarked vehicles. However, police officers recognize the unmarked vehicles will not stop these vehicles for violations of occupancy or payment requirements. It is understandable that officers will not stop police vehicles: 1) because the police vehicles may be conducting surveillance and 2) because officers rely upon their fellow officers to “watch their backs,” even on the toll facilities. Police officers and plainclothes detectives often pull over to provide backup for traffic stops on their own accord. An

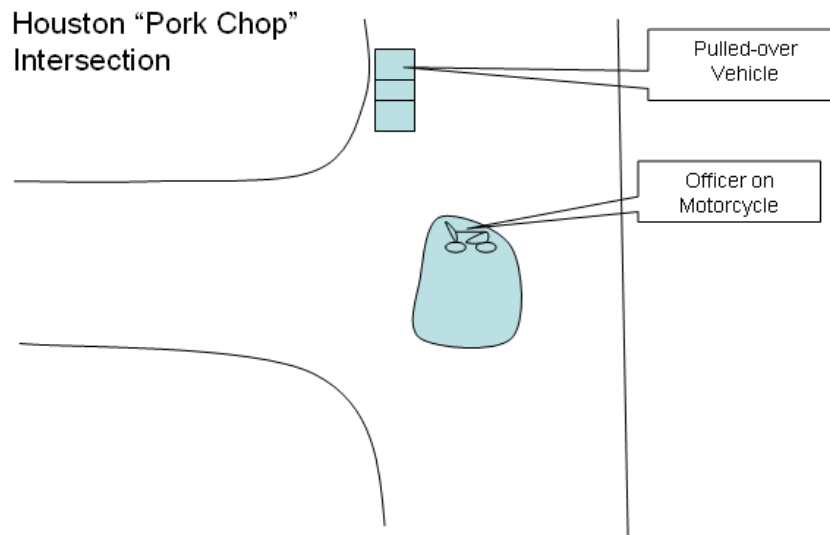
extended panel discussion ensued in which examples of specific cases where police officers undertaking enforcement actions on toll facilities were saved by off-duty officers who happened by the scene. There is no reasonable expectation that police officers or on-duty emergency personnel will be ticketed for violating toll payment or occupancy requirements.

Houston HOT Lanes

On the Houston system, toll payment and payment enforcement can be conducted at the same gantries. Gantry lights indicate when a valid transponder account has been billed for the toll. However, police officers do not look at the gantry lights to make an enforcement determination because so many of the transponders are no longer functional. Instead, the officers look for hanging tags provided to QuickRide users and try to visually enforce occupancy requirements. As mentioned earlier, HECTRA operates separate toll systems that employ standard sticker tags (the same technology that the Katy and Northwest systems are now switching to). Many of the users of the Houston systems probably believe that their HECTRA sticker works on the QuickRide system, but they do not. A confidentiality agreement is currently preventing HECTRA from providing transponder IDs to Houston METRO so that users could be properly billed. This should all resolve once the complete turnover of older TransCore tags is complete in 2008.

Enforcement of the Houston system carpool and electronic toll payments is handled entirely by manual methods. Houston METRO has their own police officers for enforcement (2 officers handling 6 lanes, mostly during peak hours). A motorcycle patrol officer will typically park at the “Pork Chop” located at the T-ramp (see Figure 1) and will attempt to pull any violating vehicles over immediately, within the space on the ramp at the intersection. The region has not moved toward automated enforcement methods primarily because their experience is that unless the method accuracy is well over 99%, they will not be supported by the courts. Moving toward the use of an Administrative Law Judge is also an option being explored in Houston, but requires legislative changes.

Figure 1: Houston "Pork Chop" Intersection



Source:

On the Houston systems, many of the pullovers turn out not to be violations and no tickets are issued. These instances consist mainly of carpools that include children or sleeping passengers that were not observed by the officer from outside the vehicle. The Texas Transportation institute has tracked violations on the Houston system through the courts. Violators often try to get repeated continuances for their hearing until they get a time slot in which the officer does not appear. Judges dismiss the case in the absence of a testifying officer.

Texas has implemented what they call the "Hero Line," which is a toll-free phone number through which users can report violators of carpool requirements. Hero signs are placed throughout the system. The Police think of this "as a great way to vent," but there is no practical follow-up to the reporting. Some letters may go out to the identified driver, but there are no teeth in the enforcement program.

In Texas, revenues associated with enforcement actions are returned to the jurisdiction in which the violation occurred. In the case of the HOT lanes, most penalties are returned directly to Houston. However, tracking violations is not easy since the METRO is separate. In about half of the cases, the violators are fined and the fine is collected, meaning that only half of the enforcement revenues are currently collected.

Minnesota MnPASS System

On the MnPASS system, enforcement is handled by both local and state officers (city officers also have the authority to pull over vehicles on the freeway). An enforcement center is used to dispatch officers.

Dedicated enforcement personnel are equipped with mobile enforcement equipment. In the MnPASS system, all enforcement actions are handled through the court system. Penalties are returned to the local jurisdictions involved (1/3 goes to the state/city/county police jurisdiction for the stop, 1/3 goes to courts, and 1/3 goes to the county). When a violation is challenged, 2/3 of the fines go to the enforcement agency to cover their additional time involved in appearing in court to enforce the violation.

Automated Enforcement

Given the costs and difficulties of manual enforcement, automated enforcement is of pressing interest to all of the toll system operators. San Diego is partnering with the Texas Transportation Institute to test the Cyclops (DTECT) remote passenger occupancy detection system (currently being field-tested in Europe). Additional information on automated enforcement is included in SANDAG Reports: 2.2.2 (2/16/06) and 2.2.5 (May 2007). In California, Legislative action will be required to implement automated enforcement techniques. MnPASS and Colorado will similarly require legislative changes before automated enforcement can be implemented to full effectiveness.

Enforcement Recommendations

- Ensure that penalties are significant for first time violations (\$100 to \$300) and that penalties increase with additional violation occurrences (\$200 to \$500)
- Consider using the SR-91 enforcement system as a potential model for Atlanta
 - The system includes video enforcement, two violation notifications with opportunity to pay, a collection agency for failures to respond, an administrative law judge for initial appeal, and the state superior court for a second appeal
- Conduct enforcement outreach with prosecutors and judges so that they will understand the importance (from a systems performance perspective) of ensuring that HOT and toll facility violations are minimized
- Ensure that penalties are returned to the corridor from which they are collected
 - Covering the enforcement and administrative costs (mailings, administrative law judge, etc.) is critical and should be legislatively ensured from the outset
- Use video (license plate) systems to identify vehicles that fail to pay tolls and integrate these enforcement systems into proposed facilities
 - Panelists indicated that the Stockholm video enforcement system is outstanding
- Ensure that the operating authority has access to the license plate database to pursue administrative enforcement actions
- Place proper signage and penalty warnings at system entrances to help prevent inadvertent violations and to remind potential violators that penalties can be significant

- Implement education policies designed to convince drivers not to use the lane illegally. However, before implementing public education campaigns, conduct a literature review on the cost-effectiveness of such campaigns
- Implement a Houston-style Hero Hotline, where drivers report carpool occupancy violations they observe on the system
 - The public reporting system may be useful if such reporting can be linked to other proposed enforcement mechanisms (e.g. if calls to an enforcement call center can trigger video review and enforcement action or if a history of hotline violation reports can be used in the adjudication process to ensure maximum fines are imposed for officer-issued violations that occur later)
- Research the potential of integrating automated enforcement systems for remote occupancy detection and for entrance/egress location violation detection

Ridesharing Activities

In San Diego, SANDAG operates the rideshare program and everything is handled in-house. SANDAG manages the carpool matching database and handle all participant survey work. The system does not do any dynamic rideshare matching. Transit information is provided by the 511 program (incidents and speeds). Along certain routes, the system provides information about the arrival time of the next bus at the station, reporting that “the next bus will arrive in 6 minutes.”

In Colorado, the MPO handles all ridesharing and vanpooling activities. The general feeling on the part of the MPO toward the toll lanes is that “as long as you don’t undercut us” we will be your partners.

In Orange County, the vanpool programs associated with the SR-91 were started in conjunction with the Orange County MTA. Approximately 20% of the vehicles operating on the system are carpools. The SR-91 outsourced survey work to determine that the average occupancy on the corridor is approximately 1.5 persons/vehicle. This means that the average HOV occupancy is 3.5 persons per vehicle (including vanpools and buses). The SR-91 is free for 3+ person carpools, except eastbound from 4-6pm when the toll is 50% off. The discount did increase the number of HOV users. A 5% increase in carpool users was noted with the 50% discount.

The Houston-Galveston Area Council (HGAC) works directly with vanpool and carpool formation. The program has a fairly large effect on carpool and vanpool use and additional information can be obtained from HGAC on their program. The HGAC does support casual carpool formation (sometimes reported in the literature as slugging) on the Katy and Northwest Freeway. The occupancy requirement for free travel is 3-persons/car, which requires “2-slugs per car.” About 30-40% of the carpooling activity appears

to be casual carpool dynamic ridesharing. Metro just recently implemented a park-n-ride lot for the facility and casual carpool formation is allowed to be operated out of the lot.

The MnPASS system has implemented some “pretty aggressive” rideshare matching activities in the past few years. Carpools receive discounts for operating on the facility. The MPO handles carpool matching services as well as the park-n-ride facilities. The COG and transit agency do the same. The DOT owns the park-n-ride land, the MPO builds the buildings, and they share in the revenue stream. In Minnesota, any transportation project that costs over \$10 million must “consider” pricing as an option in the design and operations. The linkage between the priced infrastructure and the land use zoning and mixed-use implementation appears to be the strongest in Minnesota, and to some extent in Houston.

Ridesharing Recommendations:

- Consider varying toll discounts for carpools by time of day
 - Consider allowing carpools to use the lane for free in the off-peak and for a discounted 50% toll during the peak as a reasonable approach to supporting carpool activity
 - Expand the literature review and conduct data collection as necessary to assess the percentage of carpools (and vehicle occupancy) currently operating on each of the five facilities
 - The Atlanta region is unlikely to see significantly greater carpooling fractions than are noted on these existing facilities
- Undertake a study to assess how the Atlanta region should expand outreach to increase the percentage of carpoolers that would use any proposed HOT facility
- Support close cooperation between the toll authority and the agency supporting carpooling and vanpooling activities
- Examine the role that mixed use development along HOT corridors and near park and ride facilities can play in encouraging carpooling and at transit activity
- Support casual carpool formation to the extent feasible
 - Identify locations where commuter concentrations at a reasonable distance from the facility can support such carpool formation (transit stations, park and ride lots, shopping centers, etc.)

Transportation and Air Quality Issues

The panel members were asked whether their regions had performed a full Environmental Impact Statement (EIS) or an Environmental Assessment (EA) for their respective projects under the National Environmental Policy Act (NEPA), or whether their projects were classified as Categorical Exclusions

(CEs) and exempted from NEPA analysis. The SR-91 was built as part of an already existing road space. Hence, a full EIS was conducted for SR-91. The other four projects (all were constructed after the SR-91) were classified as CEs. Panelists could generally not recall whether detailed air quality impact assessments were conducted as part of the project approval process, or whether specific analytical reports were submitted as part of the CE approval process. The MnPASS team did evaluate noise, ozone, and carbon monoxide impacts as indicators in a technical evaluation (available online). The MnPASS analyses indicated that potential ozone air pollution and noise impacts were not significant, although they did note a minor predicted increase in CO emissions. None of the regions appear to be specifically the assessing air quality impacts of their respective projects through ongoing monitoring and analysis.

Environmental Analysis Recommendations:

- Conduct additional research into the methodologies used to conduct air quality impact assessments for each project
- Undertake a detailed analysis of FHWA's recent proposal to classify HOT projects as categorical exclusions and assess the potential impacts on Atlanta HOT development
- Expand the development of travel demand model enhancements to support the evaluation of air quality impact assessments
- Undertake data collection efforts as needed to assess before and after vehicle emissions so that the actual impacts of HOT facilities can be documented

Land Use Impacts

Not much research has been conducted with respect to the potential impacts of toll facilities on local and regional land use patterns. The expert panel was not aware of any explicit studies to this effect in their respective regions.

In San Diego, San Diego State University did conduct some research on the land use impacts that may have resulted since the 1988 opening of the I-15 HOV lanes. Residential construction along the corridor exploded after the capacity expansion. However, growth has occurred throughout the entire 75+ miles corridor and not just along the carpool corridor, which may simply be the result of increased regional housing prices. Over the last 10-15 years, commuters have begun travelling to San Diego County from Riverside County for work. Since 2001-2002, SANDAG has been coordinating their regional planning activities with Riverside County, trying to strategize on creating jobs in Riverside for those living in Riverside. Similarly, the San Diego region has difficulty reconciling travel from Mexico for people going to work in San Diego. The experts in San Diego have not been able to de-couple cause-effect to isolate the impact of HOT lanes from other factors driving land use and demographic change.

With respect to the SR-91, Ed Sullivan of Cal Poly State University may have done some analysis on the effects of the facility on land use. He noted in a report that developers were selling housing with toll tags as an added incentive. The Texas Transportation Institute (Collier & Charrington) has also undertaken a study on the general impacts of toll roads and non toll roads on their respective corridors. Colorado did conduct some business impact studies that may be relevant to land use impact assessment.

In Minnesota, the Phase II Study is attempting to look at the shift in land use patterns. The Land Use and Urban Design Group at the University of Minnesota are conducting the study and an advisory panel meets every few months. However, the main focus of the study is the impact of the facility on mixed use design around park-n-ride facilities, rather than on residential development patterns and commuter decisions with respect to home purchases.

The panel agreed that additional research in the area of land use impact assessment is warranted.

Land Use Recommendations:

- The Atlanta region should form an advisory panel to plan and oversee a study on the potential land use impacts of HOT corridor projects likely to be implemented in Atlanta over the next 20 years
- Technical improvements should be made to the regional land use planning process and to the travel demand model so that the models can be used to support land use impact assessment under a variety of pricing scenarios

Other Issues:

For a system that does not price HOT access dynamically as a function of congestion levels, the frequency in which set fares are adjusted needs to be reasonable. Adjusting (i.e. raising) tolls too frequently and in too large an increment will result in complaints from the public. On SR-91, 6 week adjustments yielded constant complaints. Now, quarterly adjustments are made. The concept seems relevant to dynamic systems as well, in that changing the pricing structure too frequently can result in customer complaints.

All of the experts agreed that the ability of the operating authority to react to problems quickly is critical to operational success. The expert panel indicated that going back to fix pricing issues is very difficult once the system goes into operation. It is important that agreements forged around project implementation do not constrain operational decision making during the tenure of the project with respect to operations and pricing. That is, State Legislation and MOUs between agencies should avoid initially constraining system

prices (rates, stops, caps, specific hours, etc), so that pricing implementation can evolve and adequately respond to demand over time.

Each region has expended a significant amount of resources on development of signage for their systems. Ensuring that signage meets driver expectance is a critical element to project success. Specialized signs outlining the HOT/HOV carpool requirements, pricing, and lane entry/exit rules are required. Plus, these signs need to be distinctive to minimize confusion and reduce the number of drivers that end up in the priced lanes by mistake. Signage needs to be specially designed for each corridor.

A total of 80,000 clean vehicle permits were sold in California. No new permits are currently being sold. These permits allow the vehicles to use carpool lanes and toll facilities throughout the state for no charge. The permits are mobile in that when households change home residence county, the permits are still valid. The permits increase the value of the vehicle by approximately \$3,000-\$5,000 based upon vehicle and permit resale value. The use of the permits does affect revenue and such permits are not highly recommended from the perspective of the toll operator.

Other Issues Recommendations:

- Do not adjust toll prices and pricing structures on a HOT corridor more frequently than once per quarter
- Ensure that State Legislation and MOAs do not constrain the pricing or operations plan for the system
 - Changes may need to be made on the fly to address any operational problems that arise
- Implement proper signage
 - Proper signage is absolutely necessary for successful system implementation.
- Retain human factors consultants in preparing signage
- Establish a sign advisory committee to review all plans before deploying a system^{††}
- Do not exempt clean vehicles from toll payments
 - The percentage of such vehicles in the fleet is rising rapidly and exempting these vehicles from tolls will have a negative impact on system capacity and revenues, as seen in other areas
- If exemptions are allowed for clean vehicles, set these exemptions to expire before 2010
 - It will be important that the Legislature ensure that this occurs to minimize the problems currently seen in California related to resale values of these vehicles

^{††} Sue Chrysler at TTI was recommended by committee members as someone who could provide input into the Atlanta regional development process (she is involved in the TRB signage committee).

Expert Surveys

To further review previous implementation of congestion pricing programs, the research team conducted a survey of transportation professionals who have experience working with congestion pricing projects or programs. Approximately 60 interviews were attempted and a total of 30 surveys were completed via telephone. These surveys were broken down into entities with existing congestion pricing facilities (Form 1), entities with congestion pricing facilities in the planning process (Form 2), and entities with non-congestion priced toll facilities to facilitate a comparative analysis (Form 3).

The results of the surveys follow. For each form, there is an overview of the projects represented by the interviewees, the experience of the interviewees, a summary of the responses to the major topic areas, and lastly, detailed responses to each question.

Form 1 Interview Results – Entities with Existing Congestion Pricing Facilities

Interviews were conducted for eight congestion pricing projects that are either operational or beginning implementation. The projects include the Riverside SR-91 high occupancy toll lanes, the San Joaquin Hills Toll Road, Maryland I-95 express lanes and the Inter-County Connector (ICC), MnPASS I-394, San Diego I-15 express lanes, Lee County, FL Toll Bridges, and Houston Quickride.

The projects represent a variety of managed lanes concepts including HOT, variably-priced HOT, and Express Lanes. SR-91 in Orange County, California was the first Express lane/HOT project in the United States and the only variably-priced facility in the world when it opened in 1995. SR-91 is a 10-mile, four-lane HOT facility that is separated from general purpose lanes by pylons and a painted buffer. The facility is open to all users, but HOV-3+, motorcycles, zero-emission vehicles, and disabled license plate carriers travel free. The San Joaquin Hills Toll Road is a 12-mile section of State Route 73 in Orange County, California that was constructed as a tolled facility in 1996. The facility uses FasTrak technology which is a transponder system that is shared by multiple toll facilities in the region. The I-95 express lanes and ICC in Maryland are currently under construction and expected to be operational by 2010. The I-95 express lanes will originally be an 8-mile long barrier separated facility while the ICC will be a new 18-mile variably priced toll road. The MnPASS system on I-394 in Minneapolis, Minnesota is a variably-priced HOT facility. The 11-mile facility was constructed in 2005 by converting existing HOV lanes. It consists of a 3-mile section of barrier-separated reversible lanes and an 8-mile section of HOT lanes (one in each direction) that are separated by double white lines. The I-15 Express Lanes in San Diego are an 8-mile, 2-lane peak-period reversible HOT facility that utilizes the FasTrak system. The barrier-separated facility has two access points, one at either end of the facility. HOV-2+ vehicles can travel in the lanes for free. Two bridges in Lee County, Florida are operating with a variably-priced toll system. Full price is charged

at peak times and off-peak times while designated time periods before and after peak periods are tolled at half price. Houston QuickRide refers to two managed lanes projects on Interstate 10 and US 290. Both projects were completed by converting existing HOV lanes to HOT. The lanes are reversible and restricted to use by HOVs, with HOV 3+ vehicles traveling for free. The system is currently being expanded along US 290 (Katy Freeway). Additional information on SR-91, I-25, MnPASS, and QuickRide can be found in the literature review case studies.

The respondents to the questionnaires have spent an average of 13.4 years (range 4 – 25 years) at their current employer; have an average of 23 years (range 6 – 40 years) experience in the transportation field; and an average of 9.5 years (range 4 – 14 years) experience with congestion pricing. The responsibilities of the respondents in their respective projects were varied. They include research and advisory roles (including detailed studies of the systems), project and general management, outreach, liaison, and private consultant. The role of the employers of the respondents were equally varied including oversight of regional transportation services for a region, corridor management agency, state DOT, academic institutions, designated MPO for a region, and a consulting firm providing public relations and technical assistance.

In some instances, not every interviewee provided a response to certain questions due to not knowing the answer or non-applicability to their particular situation. The following section provides a summary of the responses obtained for each of the interview questions in 2 different forms: first, a summary of each section of questions, and second, the full text of the detailed answers.

For the purpose of this summary, projects will be referred to as: SR-91, San Joaquin Hills, Maryland, Minnesota, San Diego, Houston, and Florida where applicable.

Form 1 - Section Summaries

1. Program Description

The types of congestion pricing used include express lanes with a set pricing schedule, express lanes with dynamic pricing, a standard toll road, HOT lanes with price-dynamic shoulders, HOV and HOT lanes, and variable pricing on bridges. The various methods use concrete barriers, pylons, and double white lines to separate the tolled lanes. Also, in some cases all lanes are tolled, so no barrier is needed. Here is a brief description of each project:

The congestion pricing project on SR-91 in Orange County California consists of express lanes built in the median. The system is 10 miles long, soft-barrier separated, and has two express lanes in each direction. Pricing is done by schedule and is not changed dynamically.

The San Joaquin Hills (73) toll road, also located in Prange County, is about 15 miles long. There are three lanes that handle electronic tolling only and 6-8 lanes that can accept cash.

Maryland currently has two projects that are under construction and are expected to be operational by 2010. On I-95 NE of Baltimore, express lanes separated by jersey barriers are being added. The initial section is 8 miles long and there are plans to expand the system to 30 miles. The second project is a new road construction from Montgomery County to Prince Georges County called the Inter-county connector (ICC). This project is 18 miles long and all lanes will feature variable tolls. There are three additional segments that Maryland has in the decision making process: a section of I-270 between the beltway and I-70, the Maryland portion of the Capitol Beltway, and the MD 5 corridor south of the Beltway.

The congestion pricing project in Minnesota is an HOT lane on I-394. Part of the HOV lanes on I-35W are being converted to HOT lanes as part of a recent Urban Partnerships grant received by MnDOT. The conversion will include "price-dynamic shoulders" which will be used as shoulders to the general-purpose lanes at some hours and as congestion-priced lanes during other times, most likely peak periods. Both facilities are open to use for buses, HOVs, and SOVs paying a toll. The HOV-to-HOT conversion on I-35W is expected to be complete by September 2009.

The I-15 corridor in Southern California contains 2 concrete barrier-separated express lanes along an 8-mile stretch. The lanes were originally created as HOV-only lanes. In 1996, the pilot project (Express Pass) started with monthly decals for about 500 individuals. In 1998, the system was converted to dynamic pricing. Inductive loops in the road are used to measure congestion in the Express lanes (not in the general purpose lanes). The typical toll is about \$1.10 one way, and ranges from 50 cents to \$5.00.

There are two bridges in Lee County, Florida that are operating with variable pricing programs, the bridge connecting Cape Corral to Mainland Lee County and Mid-Point Memorial Bridge. Instead of higher peak pricing, lower off-peak shoulder pricing is used. Variable pricing discount was implemented as follows: ½ off the full toll during 30 min before AM peak; 2 hrs after AM peak; 2 hrs before PM peak; 30 min after PM peak. Full pricing is used during peak periods and other non-peak times. In November of 2007, the tolling was changed to only the westbound direction, and the tolls doubled. They are currently monitoring the situation to see how the changes affect traffic patterns. Prior to the toll change, a web survey was undertaken to see how often people adjust their travel pattern to use the off-peak pricing. About 30% indicated that they use it a few times a week. There are plans to conduct follow-up surveys.

There are two projects in the Houston, TX area. Quickride on I-10 consists of 4-5 miles that are free to HOV 3+, and HOV 2 can pay \$2. No SOVs can use the facility. The Katy Freeway has 23 miles of HOT lane expansion under construction.

In terms of effects of congestion pricing plans, on SR-91, the congestion pricing improved traffic flow. Congestion was mitigated even on the general-purpose lanes: delays on this 11 mile stretch decreased from 20-30 minutes to 10 minutes. Eventually, circa 2000, congestion on regular lanes went back up to 20-30 minutes of delay. They also saw drivers switch to off-peak shoulder times. The San Joaquin Hills facility saw drivers move to the edge of the peak period. On the I-394 facility, congestion pricing led to more efficient use of HOV lanes (less SOV violations) and contributed to the overall decrease in congestion with a lot of users having received the benefit of an expedited trip, and non-users of the HOT lane having felt a benefit in the general-purpose lanes. Also, prior to the MnPASS program, drivers were complaining about the HOV lane, which was perpetually underused—that is no longer a problem. The I-15 corridor saw improved mobility choices (guaranteed travel time), a small increase in revenue, with transit benefitting, and a BRT system is being developed for the corridor. The facilities in Lee County, FL saw a statistically measurable effect during peak period and the Quickride system has seen greater HOV use and a more open dialogue about managed lanes in Texas.

2. Obstacles to Congestion Pricing

Most respondents reported there was not much serious opposition to congestion pricing, but there were a few obstacles that were common among projects including getting political support, achieving a consensus on what prices would be and how they would be decided, becoming familiar with some relatively new technologies, and helping people to understand the changes. Many respondents also added that they thought public opinion and enforcement would be issues, but they have not become problems since implementation. Specifically, In Minnesota, Florida, and Texas, the public was much more supportive of congestion pricing programs than initially expected.

All projects did some form of public outreach prior to implementation. Tactics included: press releases, mailings, information on the website, meetings with community organizations and business groups, and always ensuring that the media was informed. In addition, all respondents say that there is currently some form of public outreach still in place to keep people up to date with pricing. It seemed to be a combination of all of these policies that made the public education process successful. One respondent also did say their advice was to leave the publicity to PR professionals.

3. Public Outreach

All of the facilities reported using extensive public outreach (including media advertising and public meetings) leading up to project implementation. Specifically, The San Joaquin Hills project utilized press releases, utility bill inserts, portable message boards, and the internet. Maryland focused their efforts on community associations, business groups, public meetings and workshops, and also used newsletters, press releases, and their website. For the Quickride project, marketing and local media were used to

inform the public. In Minnesota, a citizen jury of 24 people was randomly selected. They initially voted against congestion pricing, raising many concerns (that were later addressed). In 2001-2003, a task force of elected officials and other leaders was established. Officials conducted roundtables, involving experts on congestion pricing and tolling issues. This created open accessibility to information on congestion pricing. Research was conducted and materials were disseminated, mostly focusing on elected officials and policy leaders. Additionally, the on-going process was evaluated.

For the SR-91 facility, regular users are notified via website, email, or regular mail at least 10 days prior to rate changes. The San Joaquin Hills facility takes a “low-key” approach relying mostly on press releases and website postings. Authorities in Maryland are currently developing programs to coincide with the opening of the facilities. The Lee County, FL projects continued with regular advertising and media outreach for a year after implementation.

4. Public Acceptance of Congestion Pricing

To gather public opinion data, a couple different techniques were utilized. SR-91 utilizes yearly phone surveys (based on license plate capture and random digit dialing) to measure customer satisfaction. For the I-15 corridor, attitudinal panel surveys were conducted in 5 phases over 6 months. In Lee County, FL public surveys were conducted by phone and by mail. The Quickride project utilizes focus groups and user surveys. Maryland has not done any specific work on the concept of congestion pricing, but they did commission some studies on willingness to pay (via revealed behavior). For the I-394 corridor, task forces, open houses, and briefings with city officials were used. Additionally, five focus groups consisting of different corridor users were done.

There were few real concerns raised by the public. Some of the few mentioned include: For SR-91 there were some technology concerns, which quickly faded away. There was also some concern raised about dual taxation and there are generally some minor complaints about toll increases. Florida, Maryland, Minnesota all had mostly concerns regarding the issue of equity. Feedback from I-15 hearings was pretty much all positive.

Several projects prepared informative materials for the public. For the I-394 corridor, a marketing consultant was brought in to help with a mixture of outreach and marketing. For the I-15 facility, both SANDAG and FasTrak also prepared outreach and marketing materials. Lee County, FL used flyers, billboards, message signs and highway signs and brochures and highway signs were used for the Quickride project.

Generally, public acceptance has not been an issue for any of these projects. However, in terms of which strategies got the most support, for SR-91, a fixed toll schedule was more acceptable because people

tend to “fear the unknown”. In Minnesota, HOT Lanes and in Houston, HOV lanes have garnered the most support. On the I-15 corridor, delivery and other businesses preferred monthly passes because it made it easier to attract customers and make deliveries. In Florida, implementing a new toll on a new facility is more publicly acceptable. Additionally, raising tolls during peak period on a toll facility is acceptable.

5. Policy Tools

None of the interviewees were able to partake in lobbying efforts. All lobbying efforts were done on the part of interest groups. However, the public relations and promotions mentioned in the previous public outreach section played a part in gaining support for congestion pricing.

In terms of policies having to be changed to implement this system, most projects had to create an entity to manage aspects of the system. The SR-91 Express Lanes were built based on specific state legislature authorizing 4 demo projects. In 2001, OCTA had to be granted toll authority to operate SR-91 Express Lanes. The San Joaquin Hills Toll Road Authority was created in 1986 by legislature and was granted the power to plan, design, build, operate and toll the road. The violation fines are set up as a factor of the highest toll. For the I-394 facility, state legislation had to be changed to authorize the conversion of HOV lanes to HOT lanes. When the idea was first proposed, MnDOT had to get permission from both FHWA and the state legislature. The state legislature granted exemptions for variable pricing schemes and the local consent provision. For the I-15 facility the state legislature approved changing the HOV corridor to an HOT corridor, as long as the LOS stayed the same.

6. Technology Deployment

There are several different ways the various projects have approached toll collection technology. The SR-91 facility uses off-the shelf technology and they employed contractors for technology side. The gantries and readers used the state standard transponder (FasTrak). The technology has stayed about the same (the interviewee commented that they are using a 10-year old transponder). On the San Joaquin Hills system, violation cameras were already in place. They had to change the signs and programming and software modifications were required to implement congestion pricing. Maryland's facilities will use overhead gantries that are compatible with the EZ pass system. They will use license plate capture technology for non-EZ pass users. They are considering making the I-95 facility available only to EZ pass holders, but that decision has not yet been finalized. The Minnesota facility uses transponders with read/write capability (made by Telematriz). It reads signals at the antennae that are spaced throughout the facility and communicates to police transponders (law enforcement has a special transponder which reads other transponders) whether or not the vehicle has paid at the previous point. The I-15 facility uses the FasTrak transponder. When this technology was implemented, there were some programming issues in the first week or two, which were worked out. Florida facilities use a transponder to collect tolls and in

2007, started using video-based violation enforcement. Houston's Quickride collects tolls electronically using the EGO tag.

Most projects have instituted a combination of officer enforcement, electronic enforcement, and video enforcement. Maryland, SJH, and Florida all use video to capture licenses of violators. SR-91 and SJH both have cameras take pictures of license plates that do not have an active transponder. For SR-91, SJH, Minnesota, and San Diego officers keep an eye on who is entering and exiting lanes and taking head counts. SR-91, San Joaquin Hills, Maryland, and Florida all send their violation notices by mail. Furthermore, SR-91, San Joaquin Hills and Lee County, FL have generally seen the courts being very supportive. In the detailed responses there is a breakdown of the fines for each violation.

7. Effects of Congestion Pricing on Land Use

Generally, there were not many responses regarding effects on land use. On both the SR-91 and SJH facilities, no explicit land use studies were done. Areas around both facilities were rapidly growing or built out before the facilities were put in, and no growth could be linked to the lanes. Minnesota has seen no impacts yet since there were no major changes to the existing highway structure, but transit friendly use has been suggested for the corridor. There was a land use study conducted along the San Diego corridor. This study consisted of interviews with new residents who bought houses in the location asking them about their reasons. It appeared that the Express Lanes had a small impact when compared with schools, neighborhoods. In 2006, a similar study was done, and FasTrak was found to have had a more significant impact.

For both the SR-91 and SJH facilities it is possible that the time savings benefits may increase the value of homes in the area. Around the I-15 facility, it is not expected that there will be more than has already been seen. It is expected that the new Katy project in the Houston area will lead to major changes in land use.

On the I-394 facility there are plans to work with the UM School of Design to study changes in land use as a result of the MnPASS system. For the I-15 facility, the regional transportation model does incorporate HOV lanes and congestion pricing. They currently have 11 years of series data.

8. Effects of Congestion Pricing on Air Quality

As with land use, not many respondents were sure about the effects on air quality. For the SR-91 corridor, because of higher speeds on Express Lanes than on general purpose lanes and higher volume, the emissions are worse than otherwise. However, more micro-simulation is needed to get more reliable results. There have been mixed effects on the I-15 facility.

For SR-91 air quality was modeled Mobile and EMFAC (CA Air Resources Board equivalent) models. There is some modeling done on the San Joaquin Hills facility since they have to submit annual reports on occupancy/traffic monitoring to the local AQMD and SKAG. During the development phase of the Minnesota I-394 facility, MnDOT had to demonstrate that implementing MnPASS would not move the area from attainment into non-attainment status. On the I-15 facility, they have found mixed results: the corridor works better, so the speed is higher, and the volume is higher, hence higher emissions. However, the emissions appear to be better than under the status-quo scenario. They employed commonly used models and the CALTRANS model. There has been some modeling conducted for the upcoming Katy project.

9. Use of Revenues

A break down of the current use of revenues for each project is as follows:

The SR-91 facility was operating in the black after 1.5 – 2 years. Initially the revenues were used for debt financing and debt retirement and the private operator kept a profit. Now some of the revenue is invested in transportation services which can include multi-modal transportation. There is a focus on keeping the money in the corridor.

For SJH facilities, the revenues are paying for costs. It cost \$700 million to build San Joaquin Hills Toll road and \$100 million to acquire 23 miles of the right-of-way. The revenues are sufficient to cover the tolling equipment and debt service. The road itself is maintained by the state.

In Maryland, revenues will be sufficient to operate and maintain the corridor, but they will not cover the capital costs. The I-15 facility is covering operation and maintenance costs plus generating some revenues, and the Florida and Quickride facilities are covering operating and maintenance costs.

On the Minnesota facility, revenues did not meet original forecasts. The advisory task force recommended setting the tolls as low as possible. About a year ago a change was made to the pricing algorithm which increased the average toll. Overall usage dipped a bit, but revenues increased. Now the revenues are sufficient to operate and maintain the corridor.

All facilities are using any income inside the corridor and have no plan to use in outside the corridor. Most of the systems are fairly restricted by regulations as to how the revenues can be used. For all of the systems, putting the money back into the corridor within the scope of the regulations is seen as acceptable. Respondents reported a generally favorable reaction to the way revenues have been dispersed, and relatively no opposition.

Form 1 - Detailed Responses

1. How many years have you been at the agency (or university, etc.)?

Avg 13.4

Range 4-25

N =9

2. How many years of experience do you have in transportation?

Avg 23

Range 6-40

N = 9

In congestion pricing?

Avg 9.5

Range 4-14

N=9 (one respondent did not provide this base info)

3. What is your role/responsibility in congestion pricing?

Contributors had a variety of roles in the evaluation and implementation of congestion pricing including:

- Completing studies that looked at travelers' behavior response and traffic
- Emissions modeling
- Analysis of what would be happening to route choices and time-of-day patterns, gathering field data
- Gathering baseline data
- Conducting surveys and traffic counts
- Overseeing transportation services including buses, trains, streets and roads
- Securing funding from FHWA and approval from Board of Directors
- Evaluating potential projects.
- Research, outreach and education
- Research and advising
- Private consulting

4. What is your agency's role in the region? What geographic area is your agency responsible for?

Participants' respective agencies had several different roles in their regions including:

- Overseeing transportation services including buses, trains, streets and roads, and a toll facility

- Transportation corridor agency
- State DOT
- School of Public Affairs
- School
- Designated MPO responsible for transit planning, development and engineering
- Technical analysis and public relations

Program Description

1. Briefly describe the characteristics of your existing congestion pricing system, like corridor location, length of the corridor, type of system, etc.

- **SR-91:** The congestion pricing project on SR91 in Orange County California consists of express lanes built in the median. The system is 10 miles long, soft-barrier separated, and has two express lanes in each direction. Pricing is done by schedule and is not changed dynamically.
- **SJH (73):** The San Joaquin Hills (73) toll road, also located in Orange County is about 15 miles long. There are three lanes that handle electronic tolling only and 6-8 lanes that can accept cash.
- **San Diego:** The I-15 corridor in Southern California contains 8 miles of barrier-separated (concrete barriers) express lanes that. Currently, 2 lanes are reversible, (concrete) barrier-separated on an 8-mile stretch. The lanes were originally created as HOV-only lanes. In 1996, the Pilot project (Express Pass) started with monthly decals for about 500 individuals. In 1998, the system was converted to dynamic pricing. Inductive loops in the road are used to measure congestion in the Express lanes (not in the general purpose lanes). The typical toll is about \$1.10 one way, and ranges from 50 cents to \$5.00.
- **Maryland:** Maryland currently has two projects that are under construction and are expected to be operational by 2010. On I-95 NE of Baltimore, express lanes, separated by jersey barriers are being added. The initial section is 8 miles long and there are plans to expand the system to 30 miles. The second project is a new road construction from Montgomery County to Prince Georges County called the Inter-county connector (ICC). This project is 18 miles long and all lanes will feature variable tolls. There are three additional segments that Maryland has in the decision making process: a section of I-270 between the beltway and I-70, the Maryland portion of the Capitol Beltway, and the MD 5 corridor south of the Beltway.
- **Minnesota I-394:** The congestion pricing project in Minnesota is an HOT lane on I-394. Part of the HOV lanes on I-35W are being converted to HOT lanes as part of a recent Urban Partnerships grant received by MnDOT. The conversion will include “price-dynamic shoulders” which will be used as shoulders to the general-purpose lanes at some hours and as congestion-priced lanes during other times, most likely peak periods. Both facilities are

open to use for buses, HOVs, and SOVs paying a toll. The HOV-to-HOT conversion on I-35W is expected to be complete by September 2009.

- **Florida:** There are two bridges in Lee County, Florida that are operating with variable pricing programs, the bridge connecting Cape Corral to Mainland Lee County and Mid-Point Memorial Bridge. Instead of higher peak pricing, lower off-peak shoulder pricing is used. Variable pricing discount was implemented as follows: ½ off the full toll during 30 min before AM peak; 2 hrs after AM peak; 2 hrs before PM peak; 30 min after PM peak. Full pricing is used during peak periods and other non-peak times. In November of 2007, the tolling was changed to only the westbound direction, and the tolls doubled. They are currently monitoring the situation to see how the changes affect traffic patterns. Prior to the toll change, a web survey was undertaken to see how often people adjust their travel pattern to use the off-peak pricing. About 30% indicated that they use it a few times a week. There are plans to conduct follow-up surveys.
- **Houston:** There are two projects in the Houston, TX area; Quickride on I-10 consists of 4-5 miles that are free to HOV 3+, and HOV 2 can pay \$2. No SOV can use the facility. The Katy Freeway has 23 miles of HOT lane expansion under construction.

2. When did the system begin operating?

- **SR-91:** Express lanes began operation in December, 1995.
- **San Diego I-15:** Enabling legislation was passed in 1993, the pilot program began in 1996 and dynamic pricing was introduced in 1998.
- **SJH (73):** began as a toll road in 1996. It changed to congestion pricing, in 2000-2001.
- **Maryland:** Both projects were recently approved and construction has begun.
- **Minnesota I-394:** 2005
- **Florida:** 1998
- **Houston:** 1998

3. Are the congestion pricing lanes barrier-separated?

- **SR-91:** Pylons are used as the barrier.
- **SJH (73):** All lanes are tolled.
- **San Diego I-15:** Concrete barrier.
- **Maryland:** I-95 uses jersey barriers, ICC; all lanes are tolled.
- **Minnesota I-394:** 3 miles are separated by concrete barrier, 8 miles use double white lines.
- **Florida:** All lanes are subject to tolling.
- **Houston:** Concrete barrier separated lane (reversible).

4. Are there any vehicle occupancy requirements associated with the system?

- **SR-91:** initially began as a standard toll road with discounts for HOV 3+. HOV3+ went for free during the first 2 years, and then they started paying 50% of regular toll. In 2003 OCTA took over the operation and made the Express Lanes free for HOV3+ vehicles. Later the charge system for HOV3+ reverted to a 50% of regular toll during the “superpeak” periods.
- **Minnesota I-394:** On I-394, HOV 2+, motorcycles and busses travel for free, SOVs can use the facility for a fee.
- **San Diego:** The I-15 corridor is similar, HOV 2+ travel free and SOV pays a toll.
- **Houston:** The Quickride system allows HOV 3+ to travel free and charges HOV 2, no SOVs are allowed to use the system.
- *The Joaquin Hills toll road, both Maryland projects and the Lee County bridges have no vehicle requirements.

5. What tolls apply to HOVs and SOVs?

- **Minnesota I-394:** On the I-394 corridor, HOVs do not pay a toll, the SOV toll varies based on congestion.
- **San Diego:** I-15 uses tolls for SOVs that vary in 6-minute increments (dynamic variable pricing), HOVs, motorcycles and certain clean air designated vehicles do not pay a toll.
- The Maryland and Lee County, FL systems charge the same toll for all use.
- *The SR-91 and Quickride toll breakdown is covered in the previous question.

6. Does the congestion toll vary by time of day?

- **SR-91:** Yes, according to the toll table that is reviewed every quarter. According to predetermined schedule. The toll schedule is reviewed on quarterly basis, and the pricing for any given hour can only be increased up to two times per year.
- **SJH (73):** Yes, peak/off peak; also varies depending on payment method (cash/electronic)
- **Maryland:** I-95 – probably, but the final decision has not yet been made.
- **Minnesota I-394:** LM: Yes
- **San Diego:** Based on the congestion, not time of day, Dynamically, not by a pre-set table
- **Florida:** Yes, off-peak shoulders: 50% of regular toll, otherwise: full toll. Toll varies for different subscriber rates (by year, month, etc.)
- **Houston:** No

7. Does the congestion toll vary by congestion level?

- **SR-91:** Not dynamically. The congestion does affect how the rate table is changed. Toll schedule set based on usual congestion levels.
- **SJH (73):** Set by schedule (peak/off peak). Board of directors reviews the traffic volumes and budget. Adjusted annually. No dynamic pricing.

- **Maryland:** ICC – yes. I-95 – not yet sure.
- **Minnesota I-394:** Yes
- **San Diego:** Yes
- **Florida:** no
- **Houston:** no

8. Can trucks use the facility? If yes, what tolls do they pay?

- **SR-91:** No
- **SJH (73):** No truck restrictions on the facility. Trucks use the toll road, but have to pay extra.
- **Maryland:** Yes. Final decisions on toll differentiation are still being discussed.
- **Minnesota I-394:** Yes, up to 25,000 lbs.
- **San Diego:** No semis or very heavy vehicles (other than buses).
- **Florida:** Currently, yes/regular tolls
- **Houston:** No

9. In your opinion, what has been/is the most noticeable effect of congestion pricing?

- **SR-91:** Improved traffic flow (with addition of 2 lanes, it is not surprising). Congestion was mitigated even on the general-purpose lanes: delays on this 11 mile stretch decreased from 20-30 minutes to 10 minutes. Eventually, circa 2000, congestion on regular lanes went back up to 20-30 minutes of delay. Drivers switch to off-peak shoulder times.
- **SJH (73):** Successful in pushing people off to the edge of the peak period; transactions drop-off and revenue rise.
- **Maryland:** n/a
- **Minnesota I-394:** CP made more efficient use of HOV lane. It also contributed to the overall decrease in congestion. A drop in violation rates of SOVs in the managed lane. “They’re [SOV drivers] not hardened outlaws”; they prefer to use the lane legally, even at a small price. It has to be the ability to reduce the apparent unused space on roadway, which had previously suffered from “empty lane syndrome” [i.e. SOV drivers were resentfully eyeing space in HOV lane]. Also, a lot of users have received the benefit of an expedited trip, and non-users of the HOT lane have felt a benefit in the general-purpose lanes. There’s less grumbling than before congestion pricing was implemented. People have gradually come to understand how MnPASS works. Also, prior to MnPASS people were complaining about the HOV lane, which was perpetually underused—that’s no longer a problem.
- **San Diego:** Improved mobility choices (guaranteed travel time), Small amount of revenue, with transit benefitting, 5 Premium bus routes, every 30 minutes during peak periods. A BRT system is being developed for the corridor.
- **Florida:** Statistically measurable effect during peak period. Annual traffic growth of 3-7%.

- **Houston:** Greater HOV use and opened up dialogue for managed lanes in Texas

10. What has been the effect of congestion pricing on your current traffic volumes?

- **SR-91:** One study was finished ca 2001. Don't have the information from 1995
- **SJH (73):** We have had to adjust the rates every year for the past five years.
- **Maryland:** n/a
- **Minnesota I-394:** There has been a decrease in overall congestion; Increase in use of the lane [from when it was HOV only]; has opened up capacity in entire corridor. Variable pricing keeps the lane moving under capacity. Hasn't noticed greater throughout. They have found an improvement in the general flow of traffic up to 33%. In HOV lane, the improvement in flow is generally measured at 6% but has been as high as 15%. Throughput has improved in the general-purpose lanes at peak periods, but Buckeye is not sure how long this will last, since the area around the corridor is growing in population. MnDOT plans to continue to price the facility so that it stays at level-of-service C.
- **San Diego:** It is very challenging from the statistical point of view to analyze the impact on the general flow lanes. In 1996, the daily volume on both lanes was 9600 veh. By 2003, the total vehicle volume on the Express Lanes increased to (peaked at) 22,000 ADT. In 2004, State Route 56 was opened, connecting I-5 and I-50, which was badly needed. This new route provided a more direct trip to employment near I-5 coastal areas. As a result, the volume on I-15 has subsided. Currently, about 15,000 ADT traffic on the Express Lanes. The general corridor has experienced explosive housing growth, especially north of I-15. Likely influenced by housing trends more than by the congestion pricing program. Express Lanes likely deferred General Purpose lane building/improvement on the corridor. The Express Lanes carry up to 2000veh/lane, or about 3500/both lanes.
- **Florida:** 25% drop in morning AM peak traffic (which is 4-5% of total daily traffic), and 7% drop in PM peak traffic (which is 1-2% of total daily traffic)
- **Houston:** Has not done much for volumes due to location – 150-200 vehicles during peak

11. What has been the participation rate in the program?

- **SR-91:** You can read the final report, published in 1998, online.^{§§} Currently, 40,000 vehicles/day use the 4 Express lanes, out of 260,000 vehicles/day total on the 12 lanes.
- **SJH (73):** Don't have that figure.
- **Maryland:** n/a
- **Minnesota I-394:** There are a small fraction of corridor users who participate in the program (less than 1%). 12,000-13,000 transponders have been issued—although not all are used

^{§§} Report available at http://ceenve3.civeng.calpoly.edu/sullivan/SR91/final_rpt/sr91_report.htm

regularly; There are about 11,000 transponders currently leased out; The average user uses the lane 2–3 times per week; The facility averages 20,000 users per week.

- **San Diego:** 18,000 customers, 25,000 transponders. Many occasional users.
- The number of HOV vehicles using the corridor increased by 50% between 1998 and 2006, and the total number of vehicles using the HOV lanes increased by 66% between 1998 and 2006.
- **Florida:** 25% of people chose to use transponders. Don't have to have a transponder to use the program.
- **Houston:** It has increased.

Obstacles to Congestion Pricing

12. What are the top three obstacles you have run into when implementing congestion pricing mechanisms?

- **SR-91:**
 - In Orange County, there was not much opposition. The area (before SR-91) already had approved a network of toll roads, so the general public was used to the idea of tolls, it was not shocking. One of the first areas in the country to implement tolls.
 - In San Francisco, a similar proposal for Bay Bridge was defeated b/c of equity issues (similar to public school vouchers, Bill Locklear was involved.)
 - In Orange County, the only real equity issue was location of where the users of the facility live. Primarily, the SR-91 Express Lanes would be used by morning commuters living in Riverside and San Bernardino Counties, who would be commuting into the Orange Co and beyond. The toll lanes are right at the county border, and there is an asymmetric commute pattern. The road sits in Orange County and Orange County sets the priorities, whereas users outside of the county jurisdiction are the ones affected.
 - The local public was accepting.
- **SJH (73):**
 - No enforcement challenge (using cameras)
 - required software change for implementation
 - The biggest obstacle: Board of Directors had to agree
- **Maryland:**
 - General aversion to adding tolled lanes to a "free" highway (I-95)
 - Level of tolls
 - Lots of opposition to ICC that wasn't opposition to congestion pricing per se, but it was mostly opposition to a new highway.
- **Minnesota I-394:**

- Political Support
- Institutional buy-in by DOT and transportation officials
- Technology
- Finding the right project to pay for itself and right timing.
- There were no toll roads in Minnesota prior to MnPASS, so MnDOT had to overcome a “natural aversion” to tolls.
- Winning political support. In 1997–8 there was an attempt to institute congestion pricing on a monthly-pass basis, which failed. The dynamic-pricing setup as worked better.
- Finding a political champion. Governor Pawlenty eventually fulfilled this role, once he’d been elected.
- Give credit to the California initiatives, I-15 and SR-91, for breaking the ground for congestion pricing in US. When people could see a domestic congestion-pricing example, “a lot of the fear diminished.” The advisory committee working on congestion pricing in Minnesota was sent to California to learn more about I-15 and SR-91.
- “One of the breakthroughs” was the Value Pricing Advisory Task Force, which, over a two-year period, did a lot of public education. The Task Force was instrumental in getting support of state legislators, and eventually Governor Tim Pawlenty, in 2003.
- You can’t get “grassroots” support for tolling—it has to come from the top down.
- The biggest obstacle was the public’s attitude.
- One large public criticism was the initial closing off of a certain stretch of lanes (near the intersection with Highway 100) was initially subject to the HOV/single-payers restriction 24 hours a day; this was received very poorly by the public (as Leppik had predicted it would be). Opening the lanes to any users during off-peak periods “really calmed things down”.
- Her takeaway from this was that it’s OK to add general-purpose lanes, but don’t subtract from the general-purpose lane pool, as that will just infuriate the public. She emphasized this point several times during the conversation.
- **San Diego:**
 - This was a “lucky” project, very little resistance was met.
 - The advantages were:
 - Presence of a political champion (hoped to use extra \$ for better service)
 - Good media relationships
 - Challenges were:
 - State legislation change-passed
 - Project could not worsen the LOS on the corridor

- Technology challenges when switching from a monthly pass to a variable pricing. Mostly programming challenge. 6 minute increments are a unique achievement of this program. This set-up guarantees free flow of 62 mph 99.9% of the time.
- **Florida:**
 - Technological-electronic tolling was relatively new in 97-98
 - Tight deadlines (9 months to implement)
 - Public understanding presented an “educational hurdle.” Variable pricing was introduced simultaneously with electronic collection method.
 - Additional: the incentive was very low, 50 cents or a quarter per crossing during the off-peak shoulder.
- **Houston:**
 - Technology—integrating with Harris County Toll Authority
 - Enforcement—toll payment and occupancy

13. What obstacles did you anticipate that did not arise after implementation?

- **SR-91:**
 - Non-compete clause: Caltrans wanted to make minor improvements on the corridor, and the agreement did not allow that. A lot of articles were published indicating that this was a “robber barons” situation.
 - CPTS was a partnership of 3 groups, including Cofiroute, Granite Construction and another construction company. Cofiroute was the lead company in operating the facility (with lots of toll road experience worldwide). The two construction companies had little interest in operating the Express Lanes. Once those were built, they wanted out of the agreement. They would be happy to sell. A non-profit came forth to buy their share. There were accusations from the public indicating that Cofiroute has set up the non-profit to buy out the share and later raise tolls. There were collusion accusations, general discontent. As a result of those 2 issues, OCTA repurchased the franchise and shifted the focus from profit-generation to smooth traffic flow.
 - Occupancy violations are hard to catch, ascertained by a police officer visually when vehicles are moving at 65 mph; some violators travel with an invalid transponder/without transponder and violate repeatedly. It can be hard to collect the fines in some cases. About 2.2% transponder violations; unsure about occupancy violation rates.
- **SJH (73):**
 - Generally few issues arise.
 - Minimal loss of customers. Recently, try to keep PR low-key—that way, there is less unwanted attention when the rates go up every year.

- For 25 miles, regular freeway would take 1.5 hrs to travel. On the toll road, with a \$3.50 charge, a customer travels in 35 minutes. The advantages are significant.
- **Maryland:** None
- **Minnesota I-394:**
 - Thought there would be problems dealing with opposition by the public, however, the public are mostly supportive of the program.
- **Florida:**
 - The public was much more accepting of new technology than expected (high retiree rate on the island) and embraced the program.
- **Houston:**
 - Public opinion—discontent never emerged

Public Outreach

14. What public outreach programs did you implement before starting the program?

- **SR-91:**
 - The University did not participate in public outreach. CPTS did their own PR. The role of the university was independent evaluation.
 - Extensive public outreach to Riverside Co residents-don't know specifics.
- **SJH (73):** (When converting to congestion pricing)
 - Press releases
 - Inserts mailed out with monthly bills
 - Portable message boards
 - Published info on the web
 - Drew a lot of attention and criticism
- **Maryland:**
 - Very extensive public outreach.
 - Community associations
 - business groups
 - public meetings and workshops,
 - newsletters, press, website.
- **Minnesota I-394:**
 - In the late 1990s, a citizens jury of 24 people were randomly selected. Although they voted against CP, many concerns were raised (and later addressed). One of the major concerns was whether congestion was bad enough to warrant CP.
 - From 2001-2003, a task force was established of elected officials and other leaders. They thought that CP was a good idea, if not just for a pilot project. Engineer work determined that I-394 would be the best opportunity for CP.

- Roundtables, involving experts on CP and tolling issues, were conducted. Created open accessibility to information on CP. It was a type of broad-based education.
- Research was conducted and materials were disseminated. A communications strategy was established and marketing activities were conducted.
- Most of the work focused towards elected officials and policy leaders.
- Evaluation activities also evaluated the on-going process.
- **Florida:**
 - Budget of \$400,000 for public outreach.
 - Ads on the radio,
 - Did 60-70 presentations to rotary club meetings and similar groups of people (50-100 people at a time.) The press was also kept informed.
- **Houston:**
 - Marketing— media

15. What outreach programs are you currently implementing in conjunction with pricing implementation?

- **SR-91:** In case of toll changes, notify customers by website/e-mail/regular mail at least 10 days prior to the new rates.
- **SJH (73):** Low-key. Press releases and web postings.
- **Maryland:** Educational campaigns are currently in development for the opening of the facilities.
- **Minnesota I-394:**
 - Currently, there is a task force focusing on Phase II of I-394 CP. One idea is to create an extra lane in barrier-separated area. This would create a 3rd lane with a movable barrier to help with congestion in both directions.
 - Other topics of focus are TODs, express bus services, online services, and land use plans, in an attempt to link transportation and CP with land use.
 - Currently working with MNDOT on outreach methods (outreach plan, stakeholder workshops, etc) on UPA I-35W South Scheme which will utilize congestion pricing dynamic shoulders.
 - Right now SLPP is trying to consolidate their knowledge gained from the MnPASS project and looking at how advantages for transit could be built into an HOT lane— counter-flows for buses, for instance.
- **Florida:** After the program started, continued with regular advertisements and billboards for about 1 year.
- **Houston:** Legacy project

16. Which appear to be the most effective approaches to public relations and education?

- **SR-91:**
 - Leave it to the professional marketing people. They came up with the “Value Pricing” term.
 - Effective web page outreach, speakers to the community, TV and radio advertisements.
 - People prefer mailed notices to e-mail/website notices
- **SJH (73):**
 - When changing the toll structure only slightly, doing nothing is best. We made a bump in peak period of 1 quarter, left the other prices in place.
- **Maryland:**
 - Reaching out to the local community and business associations
 - Working with the press to generate a lot of coverage.
- **Minnesota I-394:**
 - Working with elected officials to get their support
 - All approaches worked hand-in-hand.
 - Characterizes it as a “grass tops approach”, i.e. going after not the communities to build grass-roots support, but local government officials and decision-makers. This was in part because of the legal issues involved: any local jurisdiction could’ve stopped the project in its tracks.
- **Florida:**
 - Talking to multiple small groups seems effective. Jane Doe tells her friend, and it starts a chain reaction.
 - Develop a good relationship with the media, so that they understand what you are doing
- **Houston:**
 - Did not get much exposure, inter-institutional support is crucial

17. Were public outreach efforts prior to implementation or after implementation more effective?

- **SR-91:** Not sure
- **SJH (73):** Front-end efforts more effective. Message signs helped.
- **Maryland:** n/a
- **Minnesota I-394:** Both are important. However, continuous outreach is needed on an on-going basis. When did the outreach take place? Mostly prior to the opening of the lane. There was some follow-up but not a lot. The task force wrapped up prior to the opening of the facility.

- **Florida:** Before implementation
- **Houston:** Before

Public Acceptance of Congestion Pricing

Surveys of public opinions were conducted prior to implementation via phone and via mail. In some cases both phone and mail were used together. There did not seem to be many overarching concerns raised, however some included: equity issues, environmental justice issues, safety issues, the possibility of noise, and the question of where the revenue would be spent.

18. How was information on public acceptance collected? What methods were used?

- **SR-91:** Phone surveys of those detected on the roadway (license-plate matching) and through random digit dialing. About 600-700 individuals out of 100,000 customers.
- **SJH (73):** Collected some public opinion surveys, but those were not specific to congestion pricing.
- **Maryland:** None was specifically collected on acceptance of the congestion pricing concept. A Consultant did do some willingness to pay (revealed behavior) studies.
- **Minnesota I-394:** Task forces, open houses, and briefings with city officials → all types of outreach used. Also 5 focus groups using different corridor users were done. Yet no formal public hearings. A lot of different tools were employed in terms of reaching the public. The most useful were focus groups (which “left no question unanswered”), a task force charged with public outreach, and outreach via community newspapers. At some point MnDOT formed a Community Advisory task force [may have been different from the earlier task force], of which half of the members were appointed by the governor. The members of this group became the project’s champions and were involved in MnPASS policy decisions, including setting operating hours, determining pricing and enforcement levels, and performing outreach. The Community Advisory task force was chaired by Henry van Dellen, a former state senator who “did a fantastic job of being inclusive.”
- **San Diego:** Most reliable: attitudinal panel survey, 5 waves with 6 months. Over 50 questions. Both people using I-15 FasTrak and those using a control corridor were interviewed.
- **Florida:** Public surveys by phone and by mail. Acceptance rates were in the mid-70%, and about 5% did not like the idea.
- **Houston:** Surveys and focus groups and user surveys

19. What were the major concerns that the public raised?

- **SR-91:**

- No overwhelming concerns, except right around 1999, when the scandals surrounding CPTS were going on. Because it was a private operator, the popular opinion went down (accusations of “sweetheart deal”)
- Before the facility opened, there were some technology concerns, which quickly faded away. Some concern raised about dual taxation.
- Some minor complains about toll increases-usually a very small percentage.
- **Maryland:** Some equity issues were raised, but there hasn't been a lot. Most concerns have been around the new highway construction of the ICC
- **Minnesota I-394:**
 - Equity- Is the program fair or just used by the rich? “Lexus lanes” objection
 - Work- Will the scheme work?
 - SOV using HOV lanes- Will they interfere with transit or carpooling & reduce LOS?
 - Safety- Will there be excessive weaving between lanes without barriers?
 - Noise- Will there be additional noise?
 - The lane had already been paid for. Some thought that the lane should be opened up to everyone, not just HOV users and payers.
 - Misunderstandings about entering the lane: you can bypass the metered entry ramp if you're in a carpool, but not if you're a single-payer with a transponder. Sometimes people with transponders try to bypass the queue to enter under the mistaken impression that the transponder entitles them to bypass. “I've heard [from local government officials], ‘Well, let's get this in other places.’”
- **San Diego:**
 - The corridor is generally very affluent. There were not many low-income residents. We have held 4 or 5 environmental justice hearings, those generated very little response (few people attended.) The control group consisted of I-8 users. I-8 is a corridor perpendicular to I-15, slight differences in demographics, older corridor, not as affluent, no express lanes. We have explored the following concerns:
 - Environmental justice and equity issues. However, those issues were not raised.
 - Safety issue (because it's an 8-mile no entry/exit, with concrete barriers). The perception was improved safety.
 - Would carpoolers have an issue with new users? Carpoolers accept the new arrangement as long as the LOS stays the same.
 - Perception as fair/unfair: people thought it was fair.
 - Revenue use. Responders generally did not know how the revenue was used. Preferred general improvement on the corridor. Transit was very low on the list of user-suggested uses for toll revenue

- **Florida:**
 - Not many concerns. Some people were dissatisfied because:
 - Did not think they would save much money
 - It's not fair to the working guy (who has to drive during the peak period)
- **Houston:** Not really- more so operational

20. Did you prepare public information materials before implementing the system?

- **Minnesota I-394:** Yes, a marketing consultant was brought in. It was a mixture of outreach and marketing.
- **San Diego:** SANDAG prepared the public materials. FasTrak also prepared materials.
- **Florida:** Flyers, billboards, website, radio
- **Houston:** Brochures, public message signs, highway signs

21. How would you characterize the overall acceptance of congestion pricing by the public?

- **SR-91:** Overall positive.
- **SJH (73):** Acceptance is probably 90-99%. Customers expect congestion-free experience. Annual growth in customers.
- **Maryland:**
 - Overcoming resistance to tolls in general was the toughest thing
 - The concept of varying tolls based on time and congestion was fairly well accepted
 - There were some equity concerns around the ICC
- **Minnesota I-394:** CP was pretty well accepted before and after
 - 62% thought it was a good idea.
 - 28% thought it was a bad idea.
 - The remainder did not take a side.
 - Overall acceptance of congestion pricing: MnPASS has been favorably accepted. People have realized that they have a choice (as to whether or not to use the lane); smoother operations have been observed during peak periods. People have generally respected the double white line—less confusion than anticipated over multiple entry/exit points.
- **San Diego:** Overall acceptance has not been an issue. Not changing much from wave to wave. We had very little baseline data-it would have been good to collect more baseline (pre-pricing data) for comparison.
- **Florida:** Excellent
- **Houston:**
 - Very different reactions
 - Variable pricing- "NO"

- Managed lanes (new facilities)- “Not sure yet”

22. Do you see different levels of acceptance based on demographics (race, income, age, etc.)? In what areas and how did the acceptance levels differ?

- **SR-91:** Can consult the report online for detailed info.
- Difference in frequency of use by group (most frequent users-females in their 40s, women use more than men.) People value the easier driving in the toll lanes, no trucks. People who have more money will buy more stuff; they can buy tolls just like another good. Overall, this is a very affluent corridor. The lowest income bracket in the surveys was 0-40k. Middle-aged people were more likely to use the Express lanes.
- Very homogenous user group (white, fairly affluent), don't see any response differences based on demographics
- **Maryland:**
- [From an old project that didn't get approved on US 50] There were lots of environmental justice issues raised.
- ICC – Connects Montgomery County (wealthiest in MD) with Prince Georges County (primarily Black and lower income) and this has raised some equity concerns. These concerns are breaking more on income levels than race.
- **Minnesota I-394:**
 - Yes- low income groups had slightly higher support than mid-income groups.
 - Support inside of corridor was higher than that outside of the corridor.
 - MNPass users had higher support.
 - Corridor users were more supportive because they were more familiar with it.
 - There were no “eyebrow-raising” differences in responses from different demographics. The very rich were more in favor. Support among transit riders was below 50%, possibly because they were more likely to raise equity concerns.
- **San Diego:** The project was judged as very successful. A good part of success was due to good publicity. SANDAG did a good job with publicity, the media was aware of key phases and wrote some good articles. John Smith, a mayor of one of the smaller cities in the area, was very supportive.
- **Florida:** Higher education meant slightly higher acceptance rate (barely significant difference). Increase slightly, mostly about the same
- **Houston:** They did not have research to conclude this

23. In what ways has public support changed since the inception of your program? (Have opinions become more positive or negative?)

- **SR-91:** Started at 50-50. After opening, acceptance went up to 2/3-3/4 in favor. As the congestion on general purpose lanes went back up and the scandals were arising ca. 1999, acceptance declined again.
- **SJH (73):** The public has accepted the program.
- **Maryland:** No real changes. The ICC was always controversial, but it is hard to differentiate between worries about the road itself and worries about congestion pricing.
- **Minnesota:**
 - Outreach and Education were vital. If there was opposition at the onset, it was not organized. Since inception, there has been a high level of support.
 - MnPASS has been “accepted as kind of a fact of life.” MnDOT now looking at doing something similar with “dynamic shoulders” on I-35W.
 - Yes, people have got used to it. Public opinion became less hostile after MnDOT opened the lanes by Highway 100 to off-peak users [see above].
- **Florida:** Our agency was not involved with the project past 1999.
- **Houston:** Most people don’t know about the Quickride Project

24. From your experiences, which pricing strategies have been most widely supported? Most widely criticized?

- **Supported:**
 - **SR-91:** When the marketing people did focus groups, they determined that a fixed toll schedule was more acceptable. People fear the unknown. After I-15 implementation in San Diego, there were thoughts about implementing dynamic pricing on SR-91. The technology would allow it. However, it was decided to stay with the toll schedule. In the view of potential privacy concerns, set up a numbered system for anonymous accounts, but nobody used it, so the anonymous accounts were eliminated.
 - **Minnesota I-394:** HOT Lanes
 - **San Diego:** Delivery and other businesses preferred monthly passes (easier to make deliveries and attract customers.)
 - **Florida:** New toll on a new facility is more publicly acceptable; raising tolls during peak period on a toll facility-ok
 - **Houston:** HOV
- **Criticized:**
 - **SR-91:** None Mentioned
 - **SJH (73):** SJH toll—more publicity, and therefore drew more criticism.
 - **Maryland:** N/A

- **Minnesota I-394:** Broader-based tolling; Anything extending existing tollway to entire roadway; converting existing free lane → toll lane
- **San Diego:** Regular drivers did not like monthly passes, preferred FasTrak.
- **Florida:** New toll on an already-existing facility is likely to present a problem, regardless of variable/congestion pricing
- **Houston:** Variable pricing

Policy Tools

25. Did your agency engage in any public relations or lobbying efforts prior to implementation to gain support for congestion pricing? What activities did you undertake?

- **SR-91:** The University was not involved.
- **SJH (73):** Did not need to. Legislature granted authority.
- **Maryland:** Very proactive public info campaign. By law, the department cannot lobby, but there were several interest groups that lobbied in favor of the project.
- **Minnesota I-394:** Humphrey Institute does not take positions. However, individuals within the Institute may get involved with advocacy. For example, he got involved with the education of elected officials in hopes for CP to be implemented. SLPP was mostly doing evaluation, not implementation. Metro Council didn't do anything as far as PR or lobbying; that was all handled by MnDOT.
- **Florida:** No. Had to work with Florida DOT and FHWA.
- **Houston:** As a state agency, they did not lobby.

26. What transportation policies have been or are being changed to support congestion pricing? *[Have interviewee describe the policies.]*

- **SR-91:** OCTA needed legislature approval to change the franchise. SR-91 Express Lanes were built based on specific state legislature authorizing 4 demo projects. In 2001 OCTA had to be granted toll authority to operate SR-91 Express Lanes.
- **SJH (73):** The San Joaquin Hills Toll Road Authority created in 1986 by legislature; granted the power to plan, design, build, operate and toll the road. The violation fines were set up as a factor of the highest toll (5x or 10x the highest toll.) As the tolls are getting higher, we had to modify the fine structure.
- **Maryland:** None directly.
- **Minnesota I-394:**
 - State legislation had to be changed in order to authorize the conversion of HOV lanes to HOT lanes.
 - State legislature to change pricing that changes → got exemption.
 - Local consent provision- is it required? → got exemption.

- When the idea was first proposed, MnDOT had to get permission from both FHWA and the state legislature. The Ventura administration was more interested in promoting transit than the Pawlenty administration [Pawlenty is current governor of MN]. The Pawlenty government is firmly opposed to raising gas taxes, was happy to look at congestion pricing as an alternative.
- MnDOT learned their lesson as to taking-away general-purpose lanes [see above]. MnDOT has also made accommodations to keep traffic flowing in certain areas, such as widening exit lanes.
- **San Diego:**
 - Legislature (ok'd using the HOV corridor as an HOT, as long as the LOS stays the same)
 - Using revenue on the corridor. Had to allow revenue to partially go towards bus service (Inland Breeze) on the corridor. The bus did not do well.
- **Houston:** A lot of policy, Quickride was sponsored by FHWA

27. What about other policies (fiscal, taxation, etc.)?

- **SR-91:** There is a built-in limitation of how much income could be earned on the facility (by a private operator): up to 17% of the Present Value of the facility costs. The revenue use is currently limited to O&M costs, capital costs (internal debt repayment) and corridor improvements. No revenue is allowed to be used for transit.
- **Maryland:** They used Garvey bonds for the first time.
- **Minnesota I-394:** Legislation on how excess revenues would be spent was not yet developed. Any excess revenue generated would be split between transit in corridor and corridor improvements. However, this was not yet an issue because an excess in revenue had not been generated.

Technology Deployment

Existing and evolving technologies supportive of congestion pricing:

28. Please describe the toll collection technologies that you are using or planning to use for your congestion pricing programs.

- **SR-91:** Off-the shelf technology. Had contractors for technology side. Gantries and readers used the state standard for transponder (FasTrak). The technology has stayed about the same-I am personally using a 10-year old transponder (with battery).
- **SJH (73):** Violation cameras in place. Changed the signs. Programming and software modifications were required to implement congestion pricing.
- **Maryland:** Overhead gantries with EZ pass
- License plate capture for non ez-pass users (they plan on using a system much like Toronto)

- I-95 may only be available to EZ Pass holders, but that decision has yet to be made.
- **Minnesota I-394:**
 - Transponders: “Read Write” It reads as various points. Communicates to police transponder to determine if they had paid at the previous point.
 - All electronic system. You pay by credit card online. You signup for transponder online. Enforcement has a special transponder which reads other transponders.
 - Signs: have the ability to change every 3 minutes. There are 2 prices displayed on the sign—the first is the first segment of the corridor (from downtown to Hwy 100), and the second is the total charge for driving the whole corridor (from downtown to I-494, which includes the 1st segment pricing).
 - Public responses to technology: very positive. Public initially assumed that tolls would be collected via bulky and slow toll plazas, as is the case in Chicago. Outreach helped explain that payment would be at speed.
 - Toll-collection technologies: MnPASS uses Raytheon technology.
 - The transponders are read/write devices made by Telematix. They record the last time the vehicle passed under an antenna [there are antennas spaced throughout the lane].
 - The new facility on 35W will use the same technology.
- **San Diego:** On the technology side, we were responsible for monitoring, not designing the system. When FasTrak transponder technology was implemented, there were some programming issues in the first week or two, which were worked out. For example, when a customer sees a sign that displays the toll amount, then drives on and the system volumes change, hence the price adjusts by the time the driver enters the Express lanes, the rule would be in favor of the customer: the lower toll value would always apply, whether the toll changed to a higher one or to a lower one. Had to make some adjustments to threshold values (not to be exceeded.)
- **Florida:** In 2007 upgraded to a less expensive transponder; started using Video-based violation enforcement
- **Houston:** Electronic Toll Collection (EGO Tag)

29. Please describe the vehicle occupancy verification technologies that you are using or planning to use for your congestion pricing programs.

- **SR-91:** HOVs are required to carry a transponder (which they received for free, at first.) There is a declaration lane, where the HOV3 vehicles have to pass through a dedicated lane to get the free/discounted toll. At that point, there is a spotter booth where a person counts heads and a camera to take pictures of the vehicle. The driver, not the vehicle owner is

responsible, unless the driver can't be identified. Enforcement area down the line, where a police officer can pull a vehicle over based on photo evidence.

- **Minnesota I-394:** Visual identification by law enforcement only. Must be at least 2 people for free travel. One continued issue: determining whether car contains a carpool or a single user.
- **San Diego:** Occupancy-the weakest spot. Manual verification. Customers register for a transponder, except for carpools. A transponder can be disabled with a special cover for the times a person travels with a passenger. Currently available occupancy enforcement technology is not accurate enough to implement automatic occupancy enforcement.
- **Houston:** Manual enforcement by officers

30. Please describe the enforcement technologies that you are using or planning to use for your congestion pricing programs.

a) Manual/officer enforcement?

- **SR-91:** Yes. HOV vehicles have to go through the declaration lane under the toll gantry to receive the HOV discount. A CHP (CA Highway Patrol) officer can visually observe the declared HOV vehicles. It is hard to ascertain the occupancy at prevailing speed of 65 mph.
- **SJH (73):** California Highway Patrol parks near a gantry and checks for paper plates as well as for transponder installed on the windshield. If they don't see a transponder, can pull the vehicle over.
- **Maryland:** Officer enforcement
- **Minnesota I-394:**
 - Ability to read individual transponders through special transponder located in enforcement vehicle
 - It is "critical and complex."The main method of enforcement is visual on the part of the police officer, just as it was when the facility was an HOV lane only.
 - HOVs do not need a transponder to use the facility.
 - Policemen can pull over potential violators in the three-mile reversible section.
 - Officers first check to see how many people are in the vehicle; if there is only one, checks the transponder; if there is a transponder, can read the transponder to see when the person entered the facility, and test to see whether or not the transponder works.
 - It is possible for the transponder to be mounted in the car but not on, or not working properly.
 - Officers can query the transponder and get transaction history

- Officer then writes a citation.
 - MnDOT pays for the additional cops in the corridor during hours of operation.

MnDOT also had to do extra training of those officers patrolling the corridor.
 - **San Diego:** California Highway Patrol (CHP) Officers look for cars with a missing transponder and do a visual head count, then pull suspected violators over. In 90% of the time, there is a transponder not noticed by the officer, or there was a second occupant. Because the CHP presence has increased on the corridor, the 15% occupancy violation before the I-15 Express Lanes implementation has decreased to a 3-5% occupancy violation rate with the program implementation. However, over time the violation rate has increased again.
 - **Florida:** Gates in place until 2007. Uniform traffic citation if not paying a toll. Compliance is not a big issue.
 - **Houston:** Yes
- b) Electronic enforcement?**
- **SR-91:** Yes, everyone has a transponder. License plate photo is taken in case of violation, and a notice is sent by mail. For regular lane, the people with a malfunctioning/missing transponder have a picture of their license plate taken, and a notice is sent.
 - **SJH (73):** If the credit card is expired, but the person is registered for an account, the system will notify the customer, and there is no fine. Cameras take a picture of the license plate, which is linked to the DMV records to find the violator. If not registered for an account, the driver receives a notice for an unpaid toll + fine. Up to \$10,000 fine for repeat violators.
 - **Minnesota I-394:** None
 - **San Diego:** Not present at the time of study
 - **Houston:** Yes
- c) Video enforcement?**
- **SR-91:** electronic
 - **SJH (73):** N/A
 - **Maryland:** They will use video capture to send bills to those who enter without the EZ Pass. They are calling this “toll collection” and not “enforcement” or “fines”
 - **Minnesota I-394:** None
 - **San Diego:** Not present at the time of study.
 - **Florida:** recently implemented
 - **Houston:** not sure
- d) Are violation notices sent by mail?**

- **SR-91:** Yes. At first, the private operator handled the notices. Now OCTA or a contractor issues violation notices. Can pay toll immediately (if provide account number).
 - **SJH (73):** Yes
 - **Maryland:** Bills will be sent by mail to those who enter the facility without an EZ Pass
 - **San Diego:** Not at the time of study
 - **Florida:** Yes, toll attendant used to take down the tag number and the date, if they did not pay the toll, a citation would be sent through the mail.
 - **Houston:** no
- e) Do the courts generally uphold such violation notices?**
- **SR-91:** Well-upheld in courts; the courts are very supportive.
 - **SJH (73):** Generally, very successful rate.
 - **Maryland:** n/a
 - **Minnesota I-394:** n/a
 - **San Diego:** N/A
 - **Florida:** Yes. 80-90% collection rate.
 - **Houston:** No, officer has to give out tickets

31. What are the penalties associated with:

a) Toll avoidance-

- **SR-91:** 1st notice: \$20 plus toll; 2nd notice (if not paid in 30 days) \$55 plus toll; 3rd notice \$80 plus toll plus turned over to collection agency which charges \$100/\$250/\$500
- **SJH (73):** Not sure
- **Maryland:** The decision has not been made yet, but they are considering making the “non-EZ Pass” use toll a little higher to cover the administrative costs.
- **Minnesota I-394:** LM: \$135 and moving violation
- **San Diego:** First offence-\$173
- **Florida:** For the first 30 days, only \$1 fine. If left unpaid and the violation goes to court, \$100 to LeeWay or \$150 to court.
- **Houston:** not answered

b) HOV requirements-

- **SR-91:** Normally in CA, it's a \$279 fine (for occupancy violation and crossing the line)
- **SJH (73):** N/A
- **Maryland:** n/a

- **Minnesota I-394:** \$135
- **San Diego:** \$173
- **Florida:** n/a
- **Houston:** monetary fine

c) Lane change violations (moving into or out of system outside of allowed zones)

- **SR-91:** See Above, If apprehended by a police officer, points on the driver's record
- **SJH (73):** N/A
- **Minnesota I-394:** n/a
- **Minnesota I-394:** Moving Violation
- **San Diego:** Unsure
- **Florida:** n/a

32. Are there any technologies that are not working? Please explain.

- **SR-91:** Technology works great
- **SJH (73):** Everything is ok. State-of-the art Automatic Number Plate recognition system used.
- **Maryland:** They considered manual collection, but the high cost and the physical footprint of the collection gates made this option unattractive.
- **Minnesota I-394:** Beacons were installed above various points. The beacon would light as valid transponders passed through. Enforcement doesn't use these though—instead they use the transponders in their vehicles.
- **San Diego:** Some issues early on, worked them out. Dynamic pricing worked great, MnDOT followed the example (SDSU advised on MnPASS implementation).
- **Florida:** Initially it was somewhat difficult. The software was causing problems. Transponders were not always reading during the first 3 months, had to adjust the signal timing on the antennas.
- **Houston:** no

33. Will you make a technology change, and if so what technology might you implement?

- **SR-91:** Problem for out-of state visitors, as one must have a transponder to use the Express Lanes on SR-91. Can add cash tollbooths, or do like they do on 407 and allow visitors to call-in and process a toll charge (they give their license plate number, which is taken off the list of violators at the end of the day.) 407 also got a cooperative agreement with neighbor states in the U.S., so that they can bill drivers from those states. Add occupancy verification
- **SJH:** Not planning to anytime soon.
- **Maryland:** N/A

- **Minnesota I-394:** Technology changes will not be made in the near future. The current UPA project will actually use the same technology. There has been a suggestion to use a mile-based system to supplement gas tax, but this has not yet started/ been studied.
- **San Diego:** Better enforcement.
- **Florida:** Not likely.
- **Houston:** They have considered implementing a photo system.

Effects of Congestion Pricing on Land Use

34. Has your existing program had any noticeable effect on land use? If so, what effects on land use have been observed?

- **SR-91:** Not studied (short-term study). Riverside and San Bernardino counties were high growth areas before the project, and remained that way after. Developers would give out transponders with the purchase of a house as an extra incentive. Riverside county was growing really fast before the Express Lanes were built. It has continued to grow by leaps and bounds, but it is unlikely that the growth is due to the lanes.
- **SJH (73):** Negligible. San Joaquin Hills area already built out.
- **Maryland:** n/a
- **Minnesota:** No impacts yet. Transit friendly land use has been suggested. MnPASS is mainly a “tweak” to an existing highway; land around it is already fairly well developed. You would have to introduce very heavy transit to see significant land use changes. No noticeable effect on land use. None expected, since there were no major changes to the existing highway structure.
- **San Diego:** Did a land use study along the I-15 corridor. Consisted of interviews with new residents who bought houses in the location. Asking them about their reasons (did they figure in transportation and Express Lanes? It appeared that the Express Lanes had a small impact as compared with schools, neighborhoods. In 2006, a similar study was done, and FasTrak was found to have had a more significant impact. The findings were presented at the 2007 TRB (included in the TRB CD-ROM, Supernak-first author). Explosive suburb growth in South Riverside County (people pushed out, as the price of a median house in San Diego is over \$600K, and only 5% of the area population can afford it.) Not a result of congestion pricing. Likely congestion pricing did not influence the land use very much. The program has benefitted the residents, however.
- **Florida:** No. Close to the bridge, the zoning is set in stone.
- **Houston:** No

35. What effects do you expect congestion pricing to have on local and regional land use?

- **SR-91:** With recognition of its benefits, higher demand for housing.

- **SJH (73):** Possible time savings increase the value of homes.
- **Maryland:** n/a
- **Minnesota I-394:** Not Clear yet.
- **San Diego:** About what we have found. Some effect, but not very much. Conflicting/mixed
- **Florida:** none
- **Houston:** Katy project will have HUGE land use changes

36. Have you modeled the effect of the congestion pricing system on regional land use? If so, what modeling tools have you used to model the impacts on land use?

- **SR-91:** OCTA does some land use modeling; unsure if the congestion pricing figures into the model in any way
- **SJH (73):** Land use modeling is up to the surrounding communities
- **Maryland:** n/a
- **Minnesota I-394:** SLPP is planning a future model with UM School of Design to look at changes in land use as a result of MnPASS. MnDOT has not done any studies of the effects of MnPASS on land use. It would be difficult to attribute any added sprawl to this project, in Buckeye's opinion.
- **San Diego:** Regional transportation model does incorporate HOV lanes and congestion pricing. Currently have 11 years of series data.
- **Florida:** Lee County modeling process does not account for transportation impact on forecasted land use.
- **Houston:** Katy, yes; Houston has no zoning so several displacements are taking place for Katy

Effects of Congestion Pricing on Air Quality

37. What effects do you expect congestion pricing to have on air quality?

- **SR-91:** The effects modeled were worse air quality. Because of higher speeds on Express Lanes than on general purpose lanes and higher volume, the emissions are worse than otherwise. Interviewee's personal opinion is that more microsimulation is needed to get more reliable results.
- **SJH (73):** DNA
- **Maryland:** n/a
- **Minnesota I-394:** Air quality: MnDOT has some sensors. Concern about air quality was higher in early 1990s, when I-394 was first built.
- **San Diego:** Mixed effects.
- **Florida:** Very minor change in traffic pattern, and proximity to the coast-no effect

- **Houston:** Quickride, none really.

38. Have you modeled the effect of the congestion pricing system on regional emissions? If so, what modeling tools have you used to model the impacts on emissions and air quality?

- **SR-91:** Yes, modeled air quality using Mobile and EMFAC (CA Air Resources Board equivalent) models.
- **SJH (73):** We have to submit annual reports on occupancy/traffic monitoring to the local AQMD and SKAG. They do some modeling.
- **Maryland:** n/a
- **Minnesota I-394:** Possibly done as a Cambridge Systematic Study. During the project development phase, MnDOT had to demonstrate that implementing MnPASS would not move the area from attainment to non-attainment status.
- **San Diego:** Yes. Found mixed results: the corridor works better, so the speed is higher, and the volume is higher, hence higher emissions. However, the emissions appear to be better than under the business-as-usual scenario. Moderating effect of Express Lanes. Commonly used models. CALTRANS model.
- **Florida:** No
- **Houston:** There has been some modeling on the Katy project.

Use of Revenues

39. Are the revenues sufficient to operate and maintain the priced corridor?

- **SR-91:** Yes, after 1.5-2 years, the facility was operating in the black. Initially the revenues were used for debt financing and debt retirement; the operator kept a profit. Now some of the revenue is invested in transportation services. Can use for multi-modal transportation. Focus on keeping the money in the corridor.
- **SJH (73):** The revenues are paying for costs. It cost \$700 million to build San Joaquin Hills Toll rd and \$100 million for 23 miles of the Right-of-Way. The revenues are sufficient to cover the tolling equipment and debt service. The road itself is maintained by the state.
- **Maryland:** Yes, but they will not cover the capital costs.
- **Minnesota I-394:**
 - They are now, were not initially. About a year ago a change was made to the pricing algorithm which increased the average toll. Usage dipped a bit, but revenues increased.
 - The revenues are sufficient to operate and maintain the corridor.
 - Revenues did not meet original forecasts.
 - The advisory task force recommended setting the tolls as low as possible.

- MnPASS is expected to take in about \$1.2–1.4 million in 2007, enough to cover operations and enforcement.
- Operations costs are estimated at \$1 million a year.
- The enforcement additional costs are estimated at \$165,000 a year.
- The average toll is about \$1.20.
- A time-of-day pricing “basement” was suggested—i.e. that the price would go no lower than \$1 or \$2 during peak hours. The advisory task force rejected this suggestion.
- MnDOT expects revenue to grow.
- In order to cover capital costs, MnDOT borrowed \$7 million from another state transportation fund. After operations and enforcement are paid for, the money goes towards paying back that borrowed money. Once that debt is repaid, then revenue in excess of operations costs will be split: 50% transit enhancements, 50% other transportation improvements, all within the corridor.
- It's been a while since Metro Council has received a report on how MnDOT is using the MnPASS revenue, and as far as she knows no one from Metro Council has asked for one.
- MnDOT used to give regular updates, but have stopped; she guesses because everything is running smoothly and there's nothing new to report.
- MnPASS is regarded as “a congestion thing, not a money-making thing.”
- **San Diego:** Yes with some revenue
- **Florida:** Yes
- **Houston:** Yes

40. What policies or laws are in place regarding the disbursement of revenues from congestion pricing?

- **SR-91:** Original project stimulated by 680 bill (passed in 1989). Did not want to raise the gas tax, and so invited private capital in. Later had to tweak the enforcement code for camera enforcement and to allow a private company enforcement (they contracted with CA Highway Patrol).
- **SJH (73):** Original Authority was set up to retire debt using the revenue.
- **Maryland:** They have covenants with bondholders. Revenues must stay in the toll system.
- **Minnesota I-394:** Split excess revenue after cost between transit and other improvements to corridor.
- **San Diego:** Transit funding by obligation.
- **Florida:** County and state legislature in place. A portion of the revenue can be used for transit.

- **Houston:** Quickride- METRO (wholly maintained)

41. Were any changes to law and regulation required to facilitate the disbursement of revenues from the congestion pricing program(s)?

- **SJH (73):** No
- **Maryland:** n/a
- **Minnesota I-394:** Revenues to pay for cost (\$10 million initial cost and \$1 million yearly cost)
- **San Diego:** N/A
- **Florida:** DNA
- **Houston:** don't know

42. How are the revenues from the congestion pricing program currently being used?

- **SR-91:** O&M, Improvements (including the GP lanes), internal debt repayment
- **SJH (73):** Retiring the debt, O&M
- **Maryland:** n/a
- **Minnesota I-394:** There are not excess revenues yet. First money goes to operations and maintenance. Once that's covered, the remaining revenues are split 50-50: half are reinvested in the corridor, the other half go to transit improvements. 0% of the revenue will be used outside the corridor. It is hoped that opening the 35W facility will lead to a more rapid expansion of revenue.
- **San Diego:** Revenue has varied significantly since implementation. By 2000, the facility was breaking even and generating net revenue. At that point, we started providing a subsidy to transit operations and put some money aside into an emergency fund. In 2003, before the volumes declined with the opening of SR 56, the gross revenue was at \$2.2 million. Minus \$1 million O&M expenses. \$1.1 million maximum revenue reached. Currently we are barely above the break-even point. \$1.2 million gross revenue, \$1.1 million O&M expenses. Don't anticipate any net revenue for 2008. This past year we allocated about \$400 towards transit from money set aside in previous years. By 2012, there is expected to be a significant change in the bus service on the corridor, including a new funding structure.
- **Florida:** Lee County Toll Bonding-retiring the capital debt; in the future-a third bridge

d) Are excess revenues used to support transit on the corridor?

- **SR-91:** No (not allowed)
- **SJH (73):** No
- **Maryland:** n/a
- **Minnesota I-394:** n/a
- **San Diego:** Yes

- **Florida:** Definite commitment to the corridor, upgrades on the corridor
- **Houston:** Go back into corridor
- e) **What percentage of revenues is used outside of the corridor?**
 - **SR-91:** 0%
 - **SJH (73):** Each toll corridor covers its own expenses. Exception was made to have Foothills/Eastern Toll Roads corridor direct to San Joaquin Hills Toll Road some revenue because San Joaquin Hills Toll Road was running under the 1.3 Revenue/1 Debt ratio. Since then, the ratio for San Joaquin Hills Toll Road remained right where it needs to be. Since then, Transportation Corridor System, a Joint Power Authority, has been in the process of acquiring San Joaquin Hills Transportation Corridor Agency and Foothills/Eastern Toll Road to issue new bonds and complete the toll road system.
 - **Maryland:** n/a
 - **Minnesota I-394:** n/a
 - **San Diego:** 0% during the study
 - **Florida:** 0%. If 50% or more of a road's traffic uses the bridge, it is considered part of the corridor (eligible for funding).
 - **Houston:** All goes into operations but Quickride has minimal revenue

43. What has been the public reaction to the revenue disbursement scheme?

- **SR-91:** Positive now that the facility is in public hands, and is not generating revenue for a private company.
- **SJH (73):** No adverse reaction.
- **Maryland:** n/a
- **Minnesota I-394:**
 - Relatively no opposition. Wanted to make sure \$ back into corridor—like that. Some wanted transit improvements and some wanted roads. Public reaction good because public helped design the revenue disbursement scheme. Questions about why the scheme isn't paying for itself. Thought that some excess revenue would be produced and people are wondering why it isn't.
 - Some of the legislators who supported MnPASS may have done so in the hopes of seeing greater benefits to transit—they may be a bit disillusioned now.
 - There hasn't been a systematic survey, but people have been pretty accepting. The 50-50 split between transit improvements and non-transit improvements was key to winning support from transit and highway users before MnPASS was implemented.

- Public is probably not all that well-informed. People probably don't care all that much as long as the revenues are being used appropriately and the prices aren't "outrageous." Price is usually in the \$2–3 range, very seldom hits the \$8 max.
- **San Diego:** People did not want to distribute money to transit, would prefer to spend all the revenue on the corridor roadway improvement. Generally positive acceptance of the program and transit on the corridor.
- **Florida:** Good acceptance of anything reasonable
- **Houston:** none

44. What are the most acceptable ways to use congestion pricing revenues?

- SR-91: Transit is acceptable
- SJH (73): Revenue use really restricted by regulations.
- MARYLAND: n/a
- MN: Reuse revenues in the corridor in which it was produced. Transit and road improvements. Both of which are used in the MNPass excess revenue scheme.
- San Diego: Add lanes, for operations and maintenance on the corridor.
- Houston: putting it back into the system

45. What are innovative ways that revenue from congestion pricing might be spent?

- **Minnesota I-394:** Give \$ back to the communities in corridor and let them decide how the money is used. Might decrease overall taxes, yet that raises questions about who is benefiting from it. Also might be used in dealing with equity issues, such as giving it to low-income residents.
- **San Diego:** Cross-subsidies, etc were not studied in attitudinal surveys. 45 reports on SANDAG's website.
- **Houston:** Holistic Approach- tolling augments existing revenues

46. Additional Comments at this time?

- **Minnesota I-394:**
 - There was very effective outreach in the corridor, immediately affected area, but more could have been done in the greater Minneapolis/St Paul metro area and statewide.
 - The new light-rail line^{***} was, by contrast, much higher-profile and more popular. The benefits are seen so far (statewide) as being limited to the immediate corridor.

^{***} [Hiawatha, <http://www.metrotransit.org/rail/>]

- The project hasn't generated a lot of interest in other localities; nobody's clamoring to be the next to get a variably-priced HOT lane.
- Dynamic pricing works.
- MnDOT has seen fewer accidents in the corridor because people have learned to enter and exit at designated entry/exit points.
- Violation rates are down—whereas they were 15–20%, and are as high as 35–40% on the 35W HOV lane now, since the implementation of MnPASS violation rates have fallen to 5–6%. People take advantage of having a legal choice.
- People are willing to pay to save time.
- MnDOT's enforcement strategies have been shown to work.
- People have generally been compliant with the double-white stripe separating the facility.
- You really do need a political champion to implement congestion pricing.
- She has heard complaints from people who have trouble accessing the 394/169 intersection from MnPASS lanes—you can exit the HOT lanes either well before or after the intersection. MnDOT was worried that allowing access would lead to too many people criss-crossing 394, decreasing safety.
- Her advice to other congestion-pricing projects: Make sure the public is well-informed about the system.
- Don't underestimate the public. MnDOT thought public would be confused by variable pricing, or by some lanes open at some times and others not, but public learns and adjusts quickly.
- Don't take away general-purpose lanes. MnDOT was able to convert the existing HOV lanes because they were underused. Converting general-purpose lanes would probably generate greater public resistance.
- MnPASS pricing:
 - Generally speaking, prices have been reasonable. The price “makes you gulp” if it's very high.
 - Her husband says prices have increased.
 - Drivers can use the posted prices as information, to decide whether they want to use the HOT lane, general traffic or an alternate route.
 - People who never intended to use the lane are neutral as to the prices.
- **San Diego:**
 - 13% more carpoolers use the Express Lanes now than before the program implementation. Reliability of on-time arrival is perceived as the main benefit (more so than the time savings.) People can leave 20 minutes later and use the Express Lanes if there is an unexpected delay. We see a lot more subscribers who want to

have the account for the once-in-a-while Express Lanes trip than regular users. Congestion can be overcome, as needed, and pay for itself. When doing panel surveys, there would usually be a strong voice in the group, who would sway the opinion of the other panel participants.

- 67% acceptance rate of the program across all demographic criteria.

Form 2 Interview Results – Entities with planned congestion pricing facilities

Interviews were conducted with transportation professionals about various congestion pricing projects that are in process or are currently being considered. The projects include the express toll lanes on I-75 in Southwest Florida, the I-680 Express Lanes in Alameda County, the proposed Bay Area HOT Network, as well as several others. The projects represent a wide variety of managed lanes concepts including HOT, variably-priced HOT, and Express Lanes.

The respondents to the questionnaires had spent an average of 8.75 years (range 6 – 14 years) at their current employer, have an average of 14.75 years (range 6 – 27 years) experience in the transportation field and an average of 5.6 years (range 2 – 11 years) experience with congestion pricing. The responsibilities of the respondents in their respective projects were varied. They include research and advisory roles (including detailed studies of the systems), project and general management, outreach, liaison, and private consultant. The role of the employers of the respondents were equally varied, including oversight of regional transportation services for a region, corridor management agency, state DOT, academic institutions, designated MPO for a region, and a consulting firm providing public relations and technical assistance.

In some instances, not every interviewee provided a response to certain questions due to not knowing the answer or non-applicability to their particular situation. The following report provides a summary of the responses obtained for each of the interview questions. In this section, the following acronyms are used to identify the 11 different respondents: FHWA (Federal Highway Administration), KC (Kris Cella of Cella Molnar and Associates), MDOT (Maryland Department of Transportation), ACCMA (Alameda Co Congestion Management Agency), CALTRANS (California Department of Transportation), ODOT (Oregon Department of Transportation), WSDOT (Washington State Department of Transportation), ST (Sound Transit), MacGregor (Matthew MacGregor for the Texas Department of Transportation), KATY (KATY Freeway, TX), and PANYNJ (Port Authority of New York and New Jersey).

The answers are grouped by interviewee's organization. In this section each respondent had specific knowledge about one or multiple projects. Summaries of the 9 sections of questions are located below, followed by the breakdown of detailed responses.

Form 2 - Section Summaries

1. Program Description

Projects here include the opening of HOT lanes, the converting of HOV lanes to HOT lanes, the addition of toll lanes or toll roads, use of express lanes, and combinations of several of these strategies. There are mixed reviews and plans about the separation of congestion pricing lanes with barriers. Some projects, such as CALTRANS, are planning to have a soft buffer such as pylons to separate lanes. Other projects, such as the ones in Washington State, are proposing a striped separation with partial 2- or 4-foot buffers.

The proposed congestion pricing programs also differ in the number of vehicle occupants in order to travel in the system. Pricing systems used in FHWA and KATY suggest that a high occupancy vehicle is defined as 3 or more riders. States such as California and Washington require that there be only 2 riders to be considered HOV, however, these states believe that the occupancy requirements will increase to HOV 3+ as needed to support carpooling. Some congestion pricing systems would require all vehicles, despite the number of passengers, to pay the fee, like those systems in Oregon and Minnesota.

Only a few of the proposed congestion pricing systems have detailed the toll rates and schedules to be implemented. The FHWA and KATY systems allow only HOV3+ vehicles to travel free during peak hours. Single occupancy and double occupancy vehicles would have to pay the toll during peak hours. The ACCMA and Washington state's Department of Transportation (WSDOT) will allow HOV2 vehicles to travel free, at least for the beginning of the project. Systems, such as the one in Minnesota, would charge the same for all vehicles depending on the congestion level and time of day. Most of the proposed congestion pricing systems will be based on congestion level. Minnesota, SR520 in Washington State, and MacGregor are suggesting that pricing be based on a time-of-day schedule. The Port Authority of New York and New Jersey (hereafter PANYNJ) currently uses time-of-day pricing and is proposing changes to the system to further shift traffic from the peak to the off-peak periods. All proposed congestion pricing systems in the development stages have chosen or are most likely to choose to vary tolls by congestion level. Oregon Department of Transportation (ODOT) and KC are the only two systems which have not yet decided on tolling by congestion level.

The allowance of trucks to use the congestion pricing facilities is a controversial topic. Some systems, such as ODOT, MacGregor, and PANYNJ, allow trucks to use the HOV/HOT lanes but a higher toll rate than vehicles, based on weight or time of day. KATY allows trucks and commercial buses to use the lanes for a flat rate of \$20.00 at any time of the day. Washington, ACCMA, and CALTRANS allow only small trucks to use the toll lanes. Washington SR 167 and I-405 allows for the free travel of HOV trucks, yet requires trucks to pay the same rate as vehicles if they are not HOV.

2. Obstacles to Congestion Pricing

Public acceptance serves as one challenge to the implementation of congestion pricing systems. Often, the public and public officials do not understand the pricing system and the display of toll, and therefore oppose the congestion pricing program based on a lack of knowledge. The implementation—including authorization, funding, construction, and management—and the needed legislative changes to implement congestion pricing system also cause obstacles to the program. Often times, the system stretches over many jurisdictions, questioning which agency has the authoritative role and responsibility to construct and manage the program. Another obstacle to congestion pricing is the enforcement of the lanes. Debates on the use of video versus physical enforcement by police officers, as well as the fact that there is not necessarily enough space to pull over vehicles on the roadway, serve as obstacles to the enforcement of the congestion pricing lanes.

3. Public Acceptance of Congestion Pricing

Many public hearings and public polls have been performed prior to the implementation of the congestion pricing programs. In Washington State, articles have been placed in the newspaper and the DOT has held open houses. MacGregor has implemented two surveys—a state of preference and an origins survey—to obtain public feedback on the program. KC has created an online survey as well as letters to the newspaper describing the program. The California Department of Transportation (CALTRANS) and ACCMA also implemented a survey to obtain feedback. Overall the majority of programs participated in some sort of public participation method or were planning to before the implementation of the program.

The public raised concerns about whether free-flow conditions would be maintained, thus establishing reliable time-travel. If this was hindered, there was a concern that carpoolers would disband if given the chance to maintain a short commute time for a fee. The public was also concerned about the issue of enforcement and the prevention of “cheaters” in the Express Lanes.

The proposed congestion pricing programs have either provided a large amount of public information materials—both in print or online—or are planning to closer to the implementation date. Some of the public information materials include: information, such as factsheets, videos, maps, etc., on websites; published reports, factsheets, and flyers; public hearings; and press and newspaper releases.

Overall, there is a more positive response to congestion pricing than previously. The public sees a value in the concept but are not always sure about the actual workings of the congestion pricing systems. The continuation of public outreach can help to increase public acceptance. There are not foreseen differences in levels of acceptance based on demographic. KC has suggested that blue-collar workers and carpools do not want tolls, while white-collar workers will find it affordable and worthwhile. ACCMA found that low-income respondents see a value in the toll lanes, despite having a lower income to pay for

tolls. Middle-class respondents have a concern for social equity. Overall, it was determined that time is valuable to every income group.

While some believe that dynamic pricing is more effective because people are likely to accept it, fixed/flat tolls would be the easiest to implement due to its predictability. One variation of this pricing strategy is the toll schedule, which fixes prices for different times of the day. Although the toll changes, it is still fixed and predictable. There is also support for an all-electronic system versus a cash transaction system, which further increases transportation times. The most widely criticized strategy is dynamic pricing, due to its uncertainty and large number of price points.

4. Public Outreach

There has been a large variety in the types of public outreach implemented prior to the establishment of congestion pricing systems. The majority of these outreach systems include some type of focus group, public workshop, public meeting or hearings. Online surveys have also proved beneficial in obtaining public perceptions of congestion pricing. While websites serve a vital service of disseminating information to a large number of people with relative ease, physical interaction with the public and public officials seems to be the key to public outreach of the proposed programs. Congestion pricing experts conducting public outreach are able to respond immediately and answer to the question directly. Meetings with organizations and civic groups also prove fruitful, as the information is directed towards a group of people interested in the systems and normally from similar socioeconomic backgrounds.

One type of documentation of congestion pricing systems is not effective. The campaign must be one of many fronts, including online, print, radio, and other types of announcements, in order to reach different socioeconomic groups in the most effective way. The most effective approach suggested by CALTRANS, ACCMA, and ODOT, is good media relations. Finding media who support congestion pricing ensures that the public receives a good perception of congestion pricing from the media, not those that are reactionary or entertainment-focused. Focus groups and presentations to small groups, as well as providing information on websites, print, newspaper, and billboards, prove vital to the dissemination of information to the public.

5. Policy Tools

Those respondents aware of public relations or lobbying efforts by their organization prior to implementation mostly reported that a marketing firm or other third party consultant came in to help them lobby on behalf of congestion pricing. In terms of transportation policies being changed to support congestion pricing, FHWA required new legislature because it is a Public-Private Partnership, it need to establish a state toll authority, which requires both federal and state authorization. Similarly, KC and ACCMA had to create new state agencies to dictate the revenue stream distribution and see that facilities

are maintained. MDOT did not have to change any laws, and MacGregor only had to get permits for congestion pricing passed.

6. Technology Deployment

All of the respondents to this question stated that tolls would be collected through electronic tolling—there would be no tollbooths. Video detection would also be used in some cases for enforcement to collect tolls from those who do not pay. Because some systems base tolling solely on fixed toll rates, vehicle occupancy verification is not needed for all systems. However, the major type of vehicle occupancy verification technologies suggested is for police enforcement due to the lack of verification technology currently on the market.

Officer enforcement is being used by FHWA, ACCMA, and CALTRANS to enforce the congestion pricing programs. They are assisted by the Mobile Enforcement Readers (MER units) and gantry lights, as well as by a newer version of MER technology. Electronic enforcement is being utilized by FHWA, CALTRANS, and by KATY to take a picture of the vehicle with a missing/malfunctioning transponder and send a notice to the owner, like current systems on toll bridges. On the KATY, toll violators will have their license tag photographed and sent a notice.

Violation notices sent by mail are being considered by KC, CALTRANS, Sound Transit and KATY, which will send out toll violation notices by mail. In the case of occupancy enforcement, officers in CALTRANS would have to visually note and write the ticket, as is the case with FHWA. Of those respondents who knew, the courts seem to generally uphold such violation notices. However, because most of the systems are fairly new, there is not much data on the matter.

Toll avoidance penalties vary greatly from program to program. Some programs, such as Sound Transit and ACCMA, require a fee of \$125 and \$371 respectively. Others, such as CALTRANS and KATY, require the toll amount be paid, with an additional administrative fee, often increasing with each avoidance. In the case of PANYNJ, because it covers several states, an external law firm was hired to sue non-payers in civil courts, due to the restriction by legislation to suspend licenses in multiple states by one authority.

Sound Transit and ACCMA have the same fees associated with failure to comply with HOV requirements as they do with toll avoidance. FHWA and CALTRANS have an incremental fee where the fee continues to increase with each additional offense. KATY requires a toll plus an administrative fee. A large majority of the respondents were either unsure or had not determined the fine for lane change violations, if there was one at all. ACCMA seemed to have the most stringent fine, charging for both a moving violation plus a HOV violation. Others said the fines vary, but were generally not as much.

A majority of the respondents were not currently looking for additional tolling technologies to incorporate into the HOT lanes. ACCMA was the only respondent who considered the addition of video enforcement after the implementation of the initial tolling techniques on the HOT lanes. PANYNJ expressed an interest to update the EZPass system with the replacement of traditional toll booths with gantry environments, mainly to increase traffic flows, reduce costs, and increase safety on the roads.

7. Effects of Congestion Pricing on Land Use

Most respondents were unaware of the effects of congestion pricing on land use or were going to consider it in the future. KC and MacGregor saw an increase in the use of park and ride lots and transit use/stops. Generally, the respondents did not or were unaware of modeling the effect of congestion pricing system on regional land use.

8. Effects of Congestion Pricing on Air Quality

FHWA and ODOT recognized that the MPOs were responsible for air quality modeling, while other respondents had not yet done air quality modeling. MDOT and ODOT believe that the free flow conditions will improve the air quality and get people to change their habits, yet MacGregor believes that while driving mileage may decrease, carpooling will increase, thus causing a neutral effect.

Specific modeling of the effect of congestion pricing system on regional emissions has only been performed extensively on CALTRANS, with some evaluation on FHWA and ACCMA. All other respondents said they had not studied the effect yet.

9. Use of Revenues

Some respondents were sure that revenues would be sufficient to operate and maintain the priced corridor. KC expects the revenue from the initial 2 toll lanes to fund the building of 4 additional toll lanes and ACCMA expects that there will be excess revenues. On the other hand, some respondents believe that while the revenues will not be sufficient immediately, they will in the long run or will at least prevent a future loss of revenue, such as FHWA and ODOT. ST believes that the priced corridor will not generate enough revenues for operation and maintenance and will need to be supplemented by funds from the state budget.

The FHWA and CALTRANS state that excess revenues will go to other modes of transit, such as incentives for carpools and other alternatives to SOV by FHWA and to the Express Buses in San Diego. In MDOT, all the funding goes through the Authority's general budget, where the Authority's bond holders decide the disbursement. In ACCMA, the revenues from the congestion pricing must be spent in the corridor in which they were collected. Most of the respondents stated that the laws and regulations

required to facilitate the disbursement of revenues from the congestion pricing systems was already authorized and established by the state legislatures.

There are a variety of ways the revenues from the congestion pricing programs will be used. KC and ACCMA suggest using the revenues for operations and maintenance. ODOT has considered the use of the revenues for corridor improvement only, not the use of revenue for transit. Out of those who responded, most of them responded that excess revenues will or will likely be used to support transit on the corridor. When asked about the percentage of revenues to be spent outside the corridor, respondents replied none or they were unsure. Most respondents were unsure of the public reaction to the proposed revenue disbursement scheme. The public in MDOT wants to see the revenues used for transit, while residents in ACCMA want revenues to stay in the corridor. Some of the innovative ways suggested by the respondents that revenues from congestion pricing systems could be spent included funding corridors that access the HOT corridor, maintenance, capital costs for expansion, occupancy, and enforcement.

Form 2 - Detailed Responses

47. How many years have you been at the agency (or university, etc.)?

Avg = 8.75 (without 3 missing ones)

Range= 6 – 14

N = 8

Of the eight respondents, the average number of years at the agency in which they currently work is 8.75, ranging from 6 years to the longest at 14 years.

48. How many years of experience do you have in transportation?

Avg = 14.75 (without 3 missing ones)

Range = 6 –27

N = 8

Of these same respondents, experience in transportation planning ranges from 6 years to 27 years, with the average being 14.75 years.

In congestion pricing?

Avg = 5.625 (without 3 missing ones)

Range = 2 – 11

N= 8

Despite their experience in transportation, the respondents had less experience in congestion pricing specifically. While two respondents had over 10 years experience in

congestion pricing, the majority of respondents had between two and six years experience.

49. What is your role/responsibility in congestion pricing?

Roles were varied and included:

- Lead person for FHWA HOT Lanes Initiative. Outreach, public education, some design and operations issues.
- Preliminary evaluation of different toll strategies for Express toll lanes on I-75 in Southwest Florida, including public opinion surveying. About to start Sanibel bridges variable pricing.
- Project manager for I-680 Express Lanes
- Researching current HOT trends; communication with Caltrans management regarding possible changes to the HOV policy and planning for the future
- Per mile charge study
- Policy analyst and planning
- Involved with inter-agency discussions of the proposed congestion cordon
- Co-chaired a congestion pricing panel for TRB

50. What is your agency's role in the region? What geographic area is your agency responsible for?

- Nationwide role (public education, design standards, etc.) The Capital Beltway HOT lanes and I-95/I-395 HOT lanes are two of the more recent projects that I have been assisting with.
- Private Consultant. Role Varies.
- All transportation in state of Maryland
- ACCMA: Alameda County
- Statewide DOT. In California, as of several years back, local transportation agencies now have more say over how the funding gets distributed. Local transportation agencies control 75% of the funds, and Caltrans controls only 25% of the funds. Basically, Caltrans now implements the plans that get adopted by the local transportation agencies
- State DOT. Currently no toll collection except bridges over Columbia River into Washington.
- Washington State DOT- 4 county area around Puget Sound
- 3 county regional transit provider
- Involvement in both with the proposed congestion-priced cordon around Manhattan [see <http://www.nyc.gov/html/planyc2030/html/home/home.shtml>] and the existing EZPass system [<http://www.e-zpassny.com/>].

Program Description

51. Briefly describe the characteristics of your existing congestion pricing system, like corridor location, length of the corridor, type of system, etc.

- **FHWA:**

- VDOT is implementing both projects as a PPT, with Fluor-Transurban selected as the partner.
- Capital Beltway: will have 2 new HOT lanes in each direction, for a 11-13 mile stretch between the Springfield Interchange and just north of the Dulles Toll Road. The type of separation is undecided (possibly-pylons).
<http://www.virginiahotlanes.com/beltwayproject/index.html>
- I-95/I-395 Corridor: starting with the 2 existing HOV lanes, will convert them to HOT lanes, a portion is currently reversible (2 lanes)-will add 1 lane in each direction and expand the HOT corridor to 50 miles, all the way south to Massaponax.

- **KC:**

- Corridor location, length of the corridor, type of system, etc. I-75 North/South through Southwest Florida, goes through Naples, Ft. Myers and Bonita Springs. Three cities and two counties (Lee and Collier) involved. Currently 4 lanes (2 in each direction). Will add lanes 5 and 6 (length not yet decided, around 30 miles. Arguments with one of the counties over the length.) The lanes will be added on the inside, in the current median ROW.
- 2 Phases planned. Phase 1, around 2010: 2 new inside lanes will be added (1 in each direction). Those might be tolled to generate revenue for future lane construction. Phase 2, circa 2015: 4 more toll lanes will be added. There will be 6 toll lanes and 4 general use lanes, for a total of 10 lanes (5 in each direction). About 14 miles built out.
- Southwest FL Tollway Authority answers directly to the Governor. Method for Construction and Operation is being decided:
- Build under Southwest Florida Expressway Authority
- Florida Turnpike Enterprise
- Private Concession
- All of the above
- It will be all open-road tolling. The facility will be tolled 24/7

- **MDOT:** Intercounty connector: Opening in 2012, building completely new corridor

- **ACCMA:** To be implemented by early 2010. The HOT/Express lane will operate on the current HOV corridor on I-680, on a 14-mile stretch between Hwy 84 (on the North side) and Hwy 237 (on the southern end). Of the 14 miles, 11 miles will be in Alameda county, and 3 miles will be in Santa Clara county. Entry and exit at the ends of the stretch plus two

intermediate entry points, where an acceleration/deceleration lane will be added. The facility will be tolled 24 hrs/day, 7 days/week. Dynamic pricing will be implemented, with minimum toll set at \$1. The toll can vary as often as every 3 minutes, but will likely vary every 6 or every 10 minutes. No upper toll limit has been set (and the highest toll will likely be around \$5-6). The state requires that a certain LOS be maintained on the facility. The northbound HOV lane has not been built yet, but will likely be built as an HOT lane in the future. The current HOV lane will have some modifications before congestion pricing can be implemented. The corridor connects to Bay Area and Silicon Valley.

- **CALTRANS:**

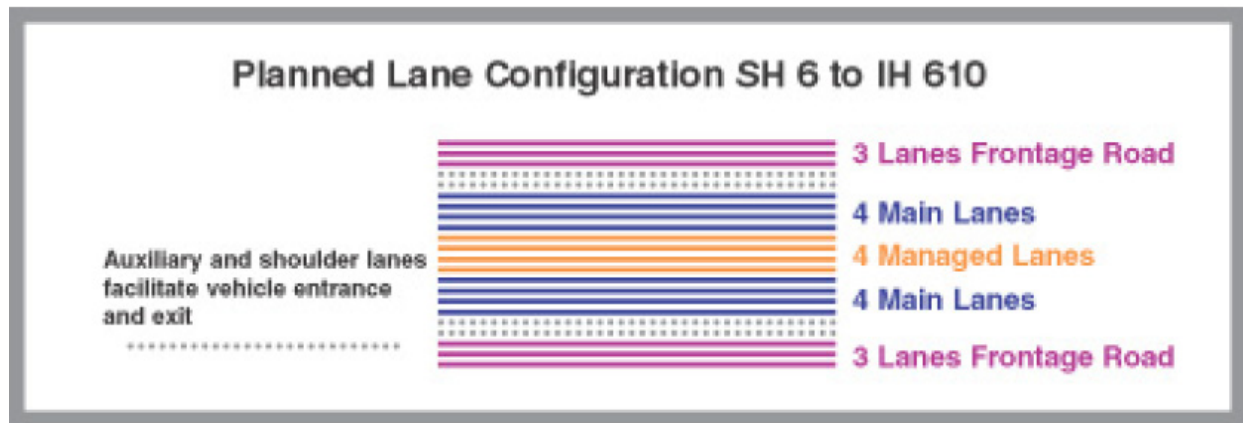
- Bay Area HOT Network will likely start with HOV to HOT conversion ca. 2015, and is projected to be completed by 2025. It will include conversion of existing HOV lanes (Caltrans 4 District-currently about 350 HOV miles), will add 10 HOV lane-miles currently under construction, and will change the 165 miles of programmed HOV lanes (funding already assigned) to be built as HOT lanes. Some HOT connectors will have to be added as needed.
- Final report describing the study done (by MTC and Caltrans):http://bayareacensus.com/planning/hov/Bay_Area_HOT_Study_Final_Report_Phase%202.pdf
- Southbound HOV lanes on I-680 and lanes on I-580 are part of the wider Bay Area HOT Network Study. Those lanes are overseen by the Alameda County Congestion Management Agency (ACCMA) and Santa Clara Congestion Management Authority. They might be converted to HOT lanes (currently online literature is using the term “Smart” Lanes) as early as 2010.
- [From FHWA website (last modified Feb. 1, 2006): “Caltrans is planning to add HOV lanes in both directions on a 14-mile segment of I-680 from Route 84 to Route 237 in Alameda and Santa Clara counties. The SMART lanes proposal would allow vehicles to pay an electronically-collected variable toll to use these lanes. The HOV/SMART lanes would be separated from the adjacent mixed-flow lanes by double yellow-striped lines. Access to the lanes would be limited to certain locations, at the beginning of the corridor and possibly one or several points along the 14-mile corridor. The access locations are still to be determined. “
[\[http://knowledge.fhwa.dot.gov/cops/hcx.nsf/2dcd3639a737386d852568d00082a9c4/e94e66d3cf053a4785256e54004a48b9/\\$FILE/Fact%20Sheet%20I-680%20SMART.pdf\]](http://knowledge.fhwa.dot.gov/cops/hcx.nsf/2dcd3639a737386d852568d00082a9c4/e94e66d3cf053a4785256e54004a48b9/$FILE/Fact%20Sheet%20I-680%20SMART.pdf)

- **ODOT:** Under consideration-statewide implementation of per-mile charge system, to replace the current vehicle sales tax. Most likely the charge will cover all of the state. Additional surcharges could be applied in certain areas.

- Phase 1 of the project, Pilot Study, successfully implemented. Recruitment in April of 2006; Switch on in June of 2006 (baseline data collection), pricing between November 06 and March 07. 285 vehicles and 299 motorists participated. 3 groups:
 - 1 small control group (no pricing throughout)
 - 1 group: flat VMT charge 1.2 cents/mile
 - 1 group: rush hour charge of 10 cents/mile; 0.43 cents/mile off-peak
- Rush hour group: 22% drop in VMT during the peak period.
- Test was completed successfully this year. Need to implement Phase 2 of the study: technical and funding evaluation. Major technology providers have expressed some interest. Technology-wise, can be done, but it will be politically difficult. It is hard to win support with the auto manufacturers. The on-board unit needs to come installed from the manufacturer to ensure good connection to the odometer (for those times when the GPS signal is not functioning.) After-market on-board units likely will not work with all the vehicles. If the program is implemented, it will take a while for the vehicle fleet to turn over-likely during the turnover phase, people will have a choice of paying regular fuel sales tax or per-mile charge.
- **WSDOT:** There are 3 projects either being implemented or in planning process:
 - SR167- HOT Lanes Pilot to finish in Spring 2008; conversion of HOV → HOT lane; 1 lane in both directions for about 9 miles
 - I-405- in design and planning phase- no authorization yet; Express toll lanes project; dual system project: conversion and lane addition as well as in another part, add lanes and convert 1 lane
 - SR520- conversion corridor → tolled corridor; 5-6 miles long; 4 lanes
- **ST:** 10 mile section of Hwy 167
- **MacGregor:** There are several projects: LBJ (20 miles), DFW Connector (20 miles), N. Terrain. Express contains three facilities. All are multiple managed lanes with 2-3 concurrent lanes.
- **KATY:** There will be 4 managed lanes from in the middle of IH 10 (Katy Freeway) from IH 610 (West Loop) to SH6. The length of the corridor is approximately 11.5 miles. There will be 3 Frontage Road Lanes in each direction, 4 Main lanes in each direction and 2 Managed lanes in each direction for a total of 18 lanes. See the diagram below^{†††}:

^{†††} Diagram provided by interviewee in written response.

Figure 2: Planned Lane Configuration, SH 6 to IH 610



- **PANYNJ:**

- The proposed cordon would include charging *within* the cordon area as well as *to cross* into the cordon area.
- A lot of vehicle-miles traveled (VMT) reduction is expected to come from those people charged to move within the cordon.
- However, this would be extremely difficult to enforce. The estimate Muriello gave was more than 340 locations within Manhattan that would need video cameras and transponder readers.
- It's possible that charging within the cordon would be eliminated; this would make the cordon easier to administer but reduce its effects on VMT.
- A commission has been established to evaluate the cordon proposal and make alternative suggestions.
- The commission is expected to make its recommendations by the end of January. The New York State legislature then has to decide whether to grant tolling authority to New York City by the end of March.
- Alternate proposals have included: reducing SOV use within the cordon (which was a tactic used both after 9/11 and during the transit strike of December 2005); rationing license plates of vehicles that can go into the cordon.
- There is a question of who would manage the cordon.
- The city originally wanted to create its own authority, which would direct revenues from the cordon towards transit improvements.
- Right now the New York City Transit Authority (NYCTA), the Metropolitan Transit Authority (MTA), and the NY State Department of Transportation are partnered with the city.
- 800,000 vehicles a day are predicted to use the cordon facility.

- It is not clear yet how the cordon would operate. The city has proposed doing 60% of the transactions via electronic toll tagging rather than video enforcement, since the transaction costs for electronic toll tagging are much lower.
- PANYNJ and the cordon:
- The executive director of PANYNJ is one of 17 commissioners on the panel established to evaluate the cordon proposal.
- There are certain accommodations PANYNJ would have to make if the cordon were established. For example, there would have to be some sort of reciprocity agreement between PANYNJ and the cordon authority so that users were not tolled twice.
- The PANYNJ is interested in the proposed revenue from a congestion-pricing scheme. For example, PANYNJ and New Jersey Transit are making a \$1 billion investment in a Hudson River tunnel—could that be supported by congestion pricing?

52. Will the congestion pricing lanes be barrier-separated?

- **FHWA:** Undecided. Possibly plastic pylons.
- **KC:** Initial 6 lanes-no barrier; ultimately-toll lanes barrier-separated.
- **MDOT:** New 6 lane facility with all lanes priced
- **ACCMA:** Double yellow line
- **CALTRANS:** Likely, with a soft buffer (pylons)
- **ODOT:** N/A
- **WSDOT:**
 - SR167- striped separation and 2 ft barrier
 - I-405- combination; striped HOT→ HOV part; 4 foot separated 2 lane part
 - SR520- no separation
- **ST:** 4 ft. buffer, double solid lines
- **MacGregor:** Mid 90's development plan began
- **KATY:** These lanes will be separated shoulders and Delineators

53. Will there be any vehicle occupancy requirements associated with the system?

- **FHWA:** HOV3+ for no toll (I-95/I-395 already has HOV3+ requirement)
- **KC:** The carpool decision has not been made yet.
- **MDOT:** No, everyone will be tolled the same
- **ACCMA:** HOV2+ to go free, SOV's pay toll
- **CALTRANS:** Likely HOV-2 at first, to be increased to HOV-3 as needed
- **ODOT:** Will likely apply to all vehicles
- **WSDOT:**
 - SR167- HOV is 2 free

- I-405- not yet determined
- SR520- not yet determined; currently 1/3 existing HOV3 lane and will probably continue but not yet sure
- **ST:** HOV 2+ converted to HOT lanes
- **MacGregor:** HOV 2+
- **KATY:** Yes, only 3+ vehicles will be allowed in the lanes for free during certain time periods. Metropolitan Transit Authority of Harris County (METRO) Busses will be allowed a certain number of trips per day for free.

54. What tolls apply to HOVs and SOVs?

- **FHWA:** HOV3+ would go free. SOVs and HOV2 pay toll.
- **KC:** Not yet decided
- **MDOT:** Everyone tolled the same
- **ACCMA:** HOV2 go free
- **CALTRANS:** Carpools would use the lanes for free
- **ODOT:** See q. 3
- **WSDOT:**
 - SR167- Free
 - I-405- not yet determined
 - SR520- not yet determined
- **ST:** \$5 to \$7 for all vehicles depending on congestion level and time of day
- **MacGregor:** Market-based pricing
- **KATY:** High Occupancy Vehicles (HOV 3+)
 - Free during peak hours (6:00 am – 11:00 am eastbound & 2:00 pm – 8:00 pm westbound)- 5 days/week
 - Vans with at least 3 occupants shall be considered HOV3
 - All other vehicles will have to pay the tolls depending on Congestion Levels of Main Lanes and Managed Lanes

55. Will the congestion toll vary by time of day?

- **FHWA:** See below
- **KC:** Not decided; likely congestion-based
- **MDOT:** Yes
- **ACCMA:** Based on congestion
- **CALTRANS:** No, by congestion level
- **ODOT:** Possibly
- **WSDOT:**

- SR167- dynamic tolling on max and min- not yet set
- I-405- dynamic tolling on max and min- not yet set
- SR520- time of day schedule
- **ST:** Yes
- **MacGregor:** Yes, 6 pricing points
- **KATY:** No
- **PANYNJ:**
 - Time-of-day pricing was implemented in 2001.
 - Right now, the base toll prices are for cash payers. Drivers get a discount for using the EZPass transponders and get a deeper discount for using the transponders during off-peak hours. This is done to persuade drivers to switch from cash to EZPass.
 - The first high-speed toll plaza is on Staten Island.
 - As of 11/15/2007, PANYNJ has proposed changes in the pricing system:
 - The peak-period discount would be eliminated altogether
 - There would be a greater differential in pricing between peak and off-peak periods.
 - The goal is to shift traffic to the off-peak period.
 - [For more information:
<http://www.panynj.gov/AboutthePortAuthority/PressCenter/PressReleases/PressRelease/index.php?id=1002>]

56. Will the congestion toll vary by congestion level?

- **FHWA:** Will vary based on congestion level
- **KC:** Not decided; likely congestion-based
- **MDOT:** Yes
- **ACCMA:** Yes
- **CALTRANS:** Yes, dynamic pricing
- **ODOT:** Not known at this point
- **WSDOT:** All yes
- **ST:** Yes
- **MacGregor:** Yes
- **KATY:** Yes

57. Will trucks be allowed to use the facility?

- **FHWA:** No. Buses-ok.
- **KC:** Not yet decided. Public opposition to tractor-trailers using the toll lanes.

- **MDOT:** Doesn't know, but thinks they probably can
- **ACCMA:** Same regulations apply as with a regular HOV lane: only 2-axle trucks can use the facility (light, delivery trucks); no semis.
- **CALTRANS:** Heavy trucks not allowed on HOV lanes and will not be allowed on HOT lanes
- **ODOT:** Trucks would not pay the per-mile charge, and congestion charge would be factored differently. Trucks already pay weight/distance-based truck fee.
- **WSDOT:**
 - SR167- no truck bigger than 2.5 tons; HOV free; if not HOV, they pay same rate
 - I-405- no truck bigger than 2.5 tons; HOV free; if not HOV, they pay same rate
 - SR520- different toll rate for trucks based on vehicular characteristics
- **ST:** No
- **MacGregor:** They'll pay more
- **KATY:** Trucks and commercial buses will have to pay a flat rate of \$20.00 no matter when.
- **PANYNJ:**
 - The facility is in effect now for both cars and trucks.
 - Trucks, in contrast with cars, currently receive a smaller discount (if they use a transponder) during peak hours and a higher discount during midday hours. It has been proposed to give trucks a steep overnight discount between the hours of midnight and 6 am.
 - A previous institution of an overnight discount did motivate a lot of truckers to get transponders (since the discounts apply to transponder users only, not cash payers) but not a big shift in volume. This may be because the affected areas lack facilities to accommodate truckers working during the night—enough places for them to stop and get coffee, for example.
 - "We've got a lot to do on the trucking side."
 - New York City is looking at how to accommodate nighttime deliveries in Manhattan.
 - The tolls charged are not enough to change the behavior of truckers, since their pay hinges so much on making the delivery on time. It's easier for them to pay higher tolls than shift delivery times.

Obstacles to Congestion Pricing

58. What are some of the obstacles you anticipate when implementing congestion pricing mechanisms?

- **FHWA:**
 - Public acceptance: VDOT has undertaken a series of focus groups and public education events. Concern from the carpool community: travel time reliability.
 - Enforcement (in some places no shoulder is possible-can't pull over)

- Design and ROW challenges
- **KC:**
 - Political opposition: one county (Collier) is not supportive of the plan.
 - A group of about 25 people opposed
- **MDOT:** Construction of new corridor was huge obstacle, but they have now gotten the approval to build, so no other big obstacles right now
- **ACCMA:**
 - 24/7 tolling might present a challenge (public opinion)
 - Funding in California is very volatile. Even though the funds for this project are allocated on the books, it is not for sure until the project is actually built.
 - Partnership with California DOT to manage the construction (to bring the lane up to standards).
- **CALTRANS:**
 - Public opposition.
 - A 2002 MTC study where both HOV-users and general lane users were interviewed indicated that people are opposed to HOT lanes. More public education and outreach will be needed. Another study in preparation for the 2034 was done, and as a result HOT lanes are now listed as low-priority.
 - Who will manage the system? It will stretch over 9 different counties, will have to figure out who will collect the tolls and how to distribute the toll revenue across the region. BATA currently oversees the bridge toll collection.
 - Some legislative changes will be necessary
- **ODOT:** It is politically difficult to get manufacturers to install devices. Until the full fleet turnover, only new cars would pay per mile/congestion charge, the rest would pay regular fuel sales tax. Fleet turnover-takes around 20 years.
- **WSDOT:**
 - SR167- they already overcame a lot of obstacles by getting authorization
 - I-405- getting authorization- faces financial, political, social issues, etc.
 - SR520- getting authorization- faces financial, political, social issues, etc.
- **ST:** Fair collection mode, enforcement, maintaining 45mph speed
- **MacGregor:** Driver communication at tolls- signage. All transponders or video build/video pay. No HOV discount without account or transponder.
- **KATY:** There will be a complex algorithm to determine pricing. This will be based on traffic levels on main lanes and frontage roads.
- Some of the main obstacles to congestion pricing included:
 - Public and political acceptance

- Authorization, funding, and legislative changes
- Construction and management of systems
- Enforcement

Public Acceptance of Congestion Pricing

59. Have you held public hearings prior to implementing the program?

- **FHWA:** Not aware (VDOT would be in charge)
- **KC:** The online survey of over 1000 respondents and letters to the newspaper.
- **MDOT:** Doesn't Know
- **ACCMA:** 60% of those polled were in favor.
- **CALTRANS:** See q. 8. 2002 MTC survey, and study for the 2035 Transportation Plan—mixed results, a lot of people opposed to HOT lanes (54% of all users, and 63% of carpoolers opposed to HOT conversion). Link to MTC survey results:
http://www.mtc.ca.gov/planning/hov/survey_results.htm
- **ODOT:** This will take place later
- **ST:** DOT has put articles in paper and had open houses
- **MacGregor:** State of Preference Survey and origins survey
- **KATY:** Do not know

60. What were the major concerns that the public raised?

- **FHWA:** Carpoolers-travel time reliability; Approval from each county would be required
- **KC:**
 - Price: people don't want to see it go up too high
 - I-75 is used for local commuting, important to keep it accessible
 - Trucks are a concern
- **MDOT:** N/A
- **ACCMA:**
 - Generally, people accept pricing but have a concern about whether the free-flow conditions will be maintained.
 - Enforcement is also a concern for the public: HOV lane users see cheaters, and think that the violation rate might be higher with Express Lanes implementation.
 - A concern that some carpools might disband given the opportunity to ride as an SOV for a fee.
- **CALTRANS:** There were no fill-in questions
- **ODOT:** So far 2 big ones noticed:

- Privacy (because vehicular movement is tracked by GPS.) This is easy to deal with. The on-board unit is not a tracking device, because it does not transmit the info continuously. The data is transmitted wirelessly when the driver stops to buy gas. The data is not kept anywhere (except the amount charged.)
- Flat rate: people think it would be unfair to hybrid owners, etc. The system, in reality, can accept any rate structure. However, the difficulty is to not re-create the gas fuel tax problem, where the higher fuel efficiencies overall create a shortage of transportation funding. We could set up a system with a base rate that would be the same for everyone, and additional penalty rates for less fuel-efficient vehicles. Or, we could maintain the fuel sales tax for the inefficient vehicles, and use the new system for the efficient ones.
- **ST:** Doesn't know
- **MacGregor:** Toll and double taxation
- **KATY:** See the EIS at <http://www.katyfreeway.org/eis.html>
- **PANYNJ:**
 - Some of the major concerns on congestion pricing programs raised by the public include:
 - Maintaining free-flow conditions and the continued use of carpools
 - The amount of the toll and the idea of double taxation
 - Enforcement of the lanes

61. Have you prepared public information materials for release before implementing the system?

- **FHWA:** Website contains factsheets, video, maps
- **KC:** Lots of public information-online, report, fact sheets, flyers (in hard copy and online.)
- **MDOT:** N/A
- **ACCMA:** Will do that closer to the date
- **CALTRANS:** Not yet
- **ODOT:** 3 Public hearings; press releases. We have not had formal hearings since it has been proven that the technology works.
- **ST:** No, has no information about public acceptance of proposed program
- **MacGregor:** Not yet
- **KATY:** Yes on the website www.katyfreeway.org. This will be undated.

62. How would you characterize the overall acceptance of congestion pricing by the public?

- **FHWA:** Overall current understanding is better than previously (Lexus lanes concern raised in the past.) In the near future, NEPA process will involve a lot of public outreach.

- **KC:** 70-80% acceptance
- **MDOT:** Come a long way in the past few years; public sees value in concept
- **ACCMA:** Positive
- **CALTRANS:** Did not ask this question
- **ODOT:** Public has to believe that the strategy creates free-flowing roads. Will find out later. It's critical to address alternative modes.
- **ST:** N/A
- **MacGregor:** Accepting pretty well so far
- **KATY:** Acceptable at this point in time. Do not think they really know how it will work

63. Do you foresee different levels of acceptance based on demographics?

- **FHWA:** Not sure. Need more education and outreach (to let people know they have a choice.)
- **KC:** Input from presentations audiences: blue-collar workers don't want tolls; there will be opposition from carpools. White-collar workers find that it will be affordable and worth their money to use.
- **MDOT:** Doesn't really foresee it but wouldn't really know without doing research on acceptance
- **ACCMA:** Did not see any difference from focus groups (which were stratified by income, age and gender). Low-income respondents see the value that those lanes will provide (they might have tighter schedule constraints, if working 2 jobs, etc.) Middle-class respondents sometimes express concern for the low-income population (perhaps they don't think that the lower-income group values their time. Which is not the case-time is valuable to every income group.)
- **CALTRANS:** It would be expected. Likely more opposition from lower-income groups. Public education is important.
- **ODOT:** Don't have the data yet
- **ST:** No
- **MacGregor:** Not seen in the surveys
- **KATY:** No

64. What are some of the areas in which acceptance differs?

- **FHWA:** N/A
- **KC:** N/A
- **MDOT:** N/A
- **ACCMA:** N/A
- **CALTRANS:** N/A

- **ODOT:** N/A
- **ST:** Generally positive because traffic has been getting worse and system is seen as the solution of the future
- **MacGregor:** N/A
- **KATY:** N/A

65. Which pricing strategies do you believe will be most widely supported? Most widely criticized?

f) Supported:

- **FHWA:** Dynamic pricing-more effective, people can accept it.
- **KC:** No cash transactions, all-electronic. Choice to pay or not to pay toll. People generally understand the need for congestion pricing (especially in Lee County).
- **MDOT:** N/A
- **ACCMA:** Fixed tolls would be easier to implement-people are familiar with toll bridges, where they know in advance what the fee would be.
- **CALTRANS:** Likely more support for a set toll schedule (people are used to how bridge tolls operate.)
- **ODOT:** Flat per-mile charge-to replace the gas charge
- **ST:** Doesn't know
- **MacGregor:** Flat price, needs to be predictable.
- **KATY:** N/A

g) Criticized:

- **FHWA:** Not sure
- **KC:** N/A
- **MDOT:** N/A
- **ACCMA:** Dynamic pricing might be difficult because of initial price uncertainty (don't know what the toll will be when you leave your house).
- **CALTRANS:** N/A
- **ODOT:** Congestion Charge. Might be more acceptable on specific corridors, as a test.
- **ST:** Doesn't know
- **MacGregor:** Having too many price points
- **KATY:** N/A

Public Outreach

66. What public outreach programs have you implemented to date?

- **FHWA:**

- VDOT: series of outreach events in 2006
- Focus groups
- HOT lanes awareness training (internal): to engineers, planners, financial people in governmental agencies
- Public Private Partnership working group
- Website and media
- **KC:** Major effort. SW Florida Expressway Authority and Florida's Turnpike Enterprise have put on two separate studies. 13 focus groups last year; began presentations to civic organizations in 05; in February 2007 there was an online survey with over 1000 respondents. Already have variable pricing in Lee County, which helps people understand the proposed project.
- **MDOT:** EIS process, lots of public outreach that this corridor has been mentioned in, but none specifically for the project. Will be more throughout the project because it is a design build project
- **ACCMA:** Some open-house meetings, focus groups and polling HOV users and corridor residents (of Alameda, Santa Clara and Contra Costa counties). More public education will happen 6 months prior to the opening (closer to 2010).
- **CALTRANS:** In conjunction with I-680/I-580 lanes, there were public workshops a couple of years ago (found some Ppt documents posted online dated September 05-Lyuba) Joseph Rouse e-mailed me a link to the report on the I-680 public outreach results: http://www.680smartlane.org/pdf/public_outreach/public_outreach_for_the_I-680.pdf. No systematic outreach has been started for the HOT network.
- **ODOT:** No formal public outreach. Some focus groups and public hearings in 2002. Presentations to groups. We are planning a survey of public opinion. The project will require a lot of public education. There has been media coverage since the end of 2002. At first, we did not have a media plan. Later we learned how to address problems and communicate effectively. Since 2004 we have been getting good media response.
- **ST:** N/A
- **MacGregor:** Focus groups, public meetings and hearings
- **KATY:** Public meetings, website, and dedicated PIO. www.katyfreeway.org.

67. Which appear to be the most effective approaches to public relations and education?

- **FHWA:** A variety of techniques. Focus groups, website, news articles.
- **KC:**
 - Small group presentations to civic groups (like Kiwanis)
 - Editorial board presentations
 - Advertisements on local radio and TV

- **MDOT:** N/A
- **ACCMA:**
 - Getting some support from the media: there is a particular columnist in the area who supports congestion pricing and writes about it.
 - Hired a public information firm, which has good media contacts.
 - Focus groups helped with public education and working out design issues
 - Between 2000 and 2006, noticed a significant increase in public acceptance of tolling: In 2000, there appeared to be very little awareness of pricing applications in transportation. People might be generally more aware of toll roads now.
- **CALTRANS:** There is a reporter working for San Jose Mercury News, who writes under the name of “el Rocho”, he talks about traffic and gives positive review of HOT lanes. ACCMA website has some materials posted explaining HOT lanes.
- **ODOT:**
 - Transparency. Every document and report has been posted on the web since the beginning. We received lots of e-mails and phone calls, and replied to all of those. The stream of phone calls/e-mails has slowed down in the past year, probably since we have adopted an ad-hoc media strategy and stopped talking to reactionary media and entertainment news.
 - For good media relations (see q. 9), there was a learning curve involved. Overall, the reporters have changed attitude (for the better), there has been an evolution, a momentum.
- **ST:** N/A
- **MacGregor:** A combination of print, radio, and billboards
- **KATY:** No opinion

Policy Tools

68. Has your agency engaged in any public relations or lobbying efforts prior to implementation to gain support for congestion pricing? What activities did you undertake?

- **FHWA:** FHWA is not allowed to lobby. The agency is responsible for information transfer and assistance with technical issues.
- **KC:** Using a marketing firm
- **MDOT:** Lobbying for extra funding from state govt. Project has gotten some federal funding too, so lobbying was probably involved
- **ACCMA:** State legislature had to be changed to make this project possible. Jean Hart did not comment on any lobbying efforts.

- **CALTRANS:** Have not yet. Will hire consultants to prepare HOV/HOT Conversion Business Plan, where one of the spelled out goals will be public outreach. Will have to be cautious with Public-Private Partnerships- based on SR-91 experience.
- **ODOT:** No firm hired and no pattern of public relations. 9 taskforce meetings held during the 1st year—lots of releases. Now journalists check in periodically. Oregon DOT website has a link to Road User Fees. Will have a final report the end of this month (November 2007).
- **ST:** No
- **MacGregor:** NEPA Project Development Process
- **KATY:** None have been done at this point

69. What transportation policies have been or are being changed to support congestion pricing?

- **FHWA:** The project required new legislature because it is a Public-Private Partnership. Need to have established state toll authority, which requires both federal and state authorization. Anytime there is a plan to introduce tolling on a federally-funded interstate or a federally-funded state route, federal approval is required. Capital Beltway: the agreement with a private partner is already in place, the toll authority is granted in the state of Virginia. Public Private Partnerships were authorized in the state of VA. I-95/I-395 will probably receive tolling authority through 23 U.S.C. 166, amended in SAFETEA-LU to allow conversion from HOVs to HOT lanes (if HOVs and motorcycles are exempt from toll).
- **KC:** Tolling Authority (SW Florida Expressway Authority)-put in place by legislature in June 2005. Will dictate the revenue stream distribution.
- **MDOT:** Since Authority is implementing, no laws have to be changed. In projects converting single lane HOV to congestion priced, changing HOV lanes over will require new policies
- **ACCMA:** State legislature was enacted to allow HOT facility on the corridor. The legislature also requires that an LOS C or D is maintained, and that all the revenue be spent on O&M for the facility, other HOV/HOT lanes in the corridor, and transit in the corridor.
- **CALTRANS:** N/A
- **ODOT:** Originally, ODOT did not have the authority to do congestion pricing study. Legislature support and involvement is critical to success; legislature changes will be required to accept this statewide as a legitimate plan. ODOT plans to draft model legislation for the Oregon State Legislature to consider beginning in 2009.
- **ST:** HOV use by non HOV vehicles. Installing toll systems
- **MacGregor:** Legislation passed permits for congestion pricing on managed lanes
- **KATY:** N/A

70. What about other policies (fiscal, taxation, etc.)?

- **FHWA:** N/A
- **KC:** Did not ask
- **MDOT:** N/A
- **ACCMA:** N/A
- **CALTRANS:** 9 counties will have to participate in a toll collection and revenue disbursement system. The HOV/HOT Conversion Business Plan will spell out needed policy/legislature changes.
- **ODOT:** This is fiscal policy in transition.
- **ST:** Possibly new policy for where revenue is allocated
- **MacGregor:** N/A
- **KATY:** N/A

Technology Deployment

Existing and evolving technologies supportive of congestion pricing

71. Please describe the toll collection technologies that you are planning to use for your congestion pricing programs.

- **FHWA:** Electronic transponders. No call tollbooths.
- **KC:** Not yet decided. Open road (electronic) tolling.
- **MDOT:** Doesn't know specifically, but there will be no toll booths
- **ACCMA:** Transponder technology is required to be interoperable for the state of California, FasTrak brand is already established. Programming and system integration will have to be worked out. Back-office solutions will be provided by Bay Area Transportation Authority (BATA).
- **CALTRANS:** Will use FasTrak.
- **ODOT:** On-Board Units: GPS component; calculates the charge on-board; connects to the odometer; will be installed by the auto manufacturers.
- **ST:** Sensors in cars are read by computers. Individuals must buy sensors
- **MacGregor:** ATC- no cash buckets, no gates. Transponder and video
- **KATY:** RFID tags, Side Fire Vehicle Detection

72. Please describe the vehicle occupancy verification technologies that you are planning to use for your congestion pricing programs.

- **FHWA:** Likely manual occupancy verification. Looking at available technologies.
- **KC:** Not yet decided.
- **MDOT:** None, all occupancy vehicles use the corridor for the same toll
- **ACCMA:** No technology will be used (manual/officer)

- **CALTRANS:** No vehicle occupancy verification technology is currently accepted as being ready to implement. The UC-Berkeley is studying such technology right now.
- **ODOT:** N/A
- **ST:** State trooper enforcement
- **MacGregor:** “eyeballs” – declaration lanes of SOV and HOV
- **KATY:** Self Declaration Lane and Manual Verification

73. Please describe the enforcement technologies that you are using or planning to use for your congestion pricing programs.

h) Manual/officer enforcement

- **FHWA:** Virginia State Hwy Patrol will play the major role, with some county enforcement. Mobile Enforcement Readers (like the ones on MnPASS) are being evaluated for use.
- **KC:** N/A
- **MDOT:** N/A Doesn’t know specifically
- **ACCMA:** Officer enforcement, assisted by Minnesota-style MER units, gantry lights and a newer version of MER’s that would be usable by officers on motorcycles.
- **CALTRANS:** California Highway Patrol-based
- **ODOT:** Have not considered-not part of the study
- **ST:** Yes
- **MacGregor:** Light inside of car
- **KATY:** Verification of Occupants in vehicles for HOV

i) Electronic enforcement

- **FHWA:** For transponder vehicles.
- **KC:** N/A
- **MDOT:** N/A
- **ACCMA:** None
- **CALTRANS:** For missing/malfunctioning transponder will likely take a picture and send a notice, as it is done now on tolled bridges.
- **ODOT:** N/A
- **ST:** No
- **MacGregor:** N/A
- **KATY:** Electronic Toll Collection

j) Video enforcement

- **FHWA:** N/A
- **KC:** Will likely be used
- **MDOT:** N/A

- **ACCMA:** None (possible in the future)
- **CALTRANS:** N/A
- **ODOT:** N/A
- **ST:** Thinks no
- **MacGregor:** No
- **KATY:** Toll violators will have license tag photographed

k) Are violation notices sent by mail?

- **FHWA:** No, officer writes tickets.
- **KC:** LeeWay Authority currently sends out toll violation notices by mail (for Lee Co Toll Bridges). Will likely continue to use this practice.
- **MDOT:** Doesn't know
- **ACCMA:** No (BATA rules)
- **CALTRANS:** For simple toll facilities (like the toll bridges) it is currently done. With occupancy enforcement, an officer would have to verify visually and write out the ticket in person.
- **ODOT:** N/A
- **ST:** Yes
- **MacGregor:** No
- **KATY:** yes

l) Do the courts generally uphold such violation notices?

- **FHWA:** In Virginia-generally ok.
- **KC:** Generally-yes.
- **MDOT:** Doesn't know
- **ACCMA:** Cannot answer/no experience
- **CALTRANS:** Did not ask this question
- **ODOT:** N/A
- **ST:** Probably, but new system so not much data
- **MacGregor:** No
- **KATY:** This are administration fees.

74. What are the penalties associated with:

m) Toll avoidance

- **FHWA:** Not aware
- **KC:** Have not determined yet
- **MDOT:** Doesn't know
- **ACCMA:** \$371

- **CALTRANS:** 1st violation: toll amount +\$25; 2nd violation: toll + \$70, etc
- **ODOT:** Not considered. Likely will be civil penalties. We will be identifying violators at the pump: when the person fills up, the vehicle id shows up in the system, and it will be easy to tell if someone has been cheating the system.
- **ST:** Citation- ~\$125
- **MacGregor:** Mailed invoice- non payment fee
- **KATY:** The toll plus an administrative fee
- **PANYNJ:** EZPass and toll enforcement:
 - For EZPass, they “need more teeth in the collection process.”
 - Right now you cannot have your driver’s license suspended for failing to pay an EZPass Toll (in the PANYNJ’s area of authority, at least).
 - Pennsylvania’s response to this is to hire two external law firms to sue non-payers in civil courts. [Remember that EZPass covers several states.]
 - In order for PANYNJ to be able to suspend licenses, legislation would need to be passed at the very least in New York and New Jersey, and possibly in Connecticut, Pennsylvania, and Massachusetts as well.

n) HOV requirements

- **FHWA:** In stages, first offence: \$125, second offense: \$250; third offence: \$500; fourth offense: \$1000 + 3pts.
- **KC:** Have not determined yet
- **MDOT:** None
- **ACCMA:** \$371
- **CALTRANS:** 1st violation: \$351 minimum, and goes up
- **ODOT:** N/A
- **ST:** Citation- ~\$125
- **MacGregor:** \$60-\$200 fine
- **KATY:** The toll plus an administrative fee

o) Lane change violations (moving into or out of system outside of allowed zones)

- **FHWA:** Not aware
- **KC:** Have not determined yet
- **MDOT:** None
- **ACCMA:** Moving violation + HOV violation (possibly a larger fine, plus points off-not sure about this)
- **CALTRANS:** Will likely be treated similar to HOV requirement violation
- **ODOT:** N/A
- **ST:** Most likely moving traffic violation, not as much money
- **MacGregor:** Fines vary

- **KATY:** Do not know what the penalty will be

75. Are there any other technologies that you considered using? Why did you decided against using them?

- **FHWA:** Not aware
- **KC:** All tolling authorities in the state of Florida are interoperable, by agreement. Will use already-existing technology.
- **MDOT:** N/A
- **ACCMA:** Video enforcement in the future
- **CALTRANS:** Currently not looking outside of FasTrak
- **ODOT:** Retrofit OBUs for existing vehicles-does not always work, depending on the vehicle model.
- **ST:** No
- **MacGregor:** No
- **KATY:** N/A
- **PANYNJ:**
 - EZPass technology changes:
 - The EZPass system is now ten years old, so PANYNJ is re-evaluating the current collection methods.
 - They are replacing at least some of the traditional toll booths with gantry environments.
 - This should increase traffic flows, as the current toll plazas are very inefficient.
 - It would reduce costs, since PANYNJ would have to pay fewer workers.
 - It should also be safer, since there are frequently fender-benders as people try to merge coming out of the traditional toll booths.
 - There might be a benefit to air quality, as some drivers will be able to pass freely under the gantry instead of having to slow down and stop for the booth.
 - The system will look similar to that used by the 407 highway in Toronto.
 - More will be charged to those who use the gantry but do not have the transponder, or the transponder doesn't read (video enforcement).
 - Only 2% of transactions are processed in this way right now. After the changes it might go up to 10-15%.
 - Right now about 25% of EZPass users pay with cash. This still requires a lot of staff.
 - Even if, after the shift, only 10% of users are cash payers, this will still require a significant investment in staffing on PANYNJ's part.

Effects of Congestion Pricing on Land Use

76. What effects do you expect congestion pricing to have on local and regional land use?

- **FHWA:** Have not studied this element
- **KC:** Land use patterns are already set; there might be some areas re-designed to use for park-n-ride lots and transit stops.
- **MDOT:** It is being studied currently, but doesn't know results of the study
- **ACCMA:** No
- **CALTRANS:** Not sure
- **ODOT:** Not considered-will be part of Phase II of the study.
- **ST:** None
- **MacGregor:** Increase in park and ride lots and transit use
- **KATY:** None

77. Do you plan to model the effect of the congestion pricing system on regional land use, and if so, how?

- **FHWA:** N/A
- **KC:** Lee Co and Collier Co do comprehensive land use planning; they consider transport. They might incorporate the effect of tolled lanes.
- **MDOT:** N/A
- **ACCMA:** No. Regional Modeling done by MTC (Metropolitan Transportation Commission)
- **CALTRANS:** Did not ask
- **ODOT:** No. Portland METRO does some regional modeling, 2-3 other regional agencies do modeling. Counties do their own urban plans. Oregon State University has started the land use modeling process.
- **ST:** No
- **MacGregor:** MPO might
- **KATY:** Do not know

Effects of Congestion Pricing on Air Quality

78. What effects do you expect congestion pricing to have on air quality?

- **FHWA:** DC MPO includes air quality modeling as part of the travel demand model.
- **KC:** Have not done any air quality analysis yet. Might be done in Phase 2.
- **MDOT:** Thinks getting people to change habits will have an effect on emissions
- **ACCMA:** Did not ask
- **CALTRANS:** Did not ask

- **ODOT:** Free flow conditions will likely improve the air quality. MPO's are primarily responsible for air quality modeling.
- **ST:** None right now
- **MacGregor:** Neutral- carpooling increase and driving mileage decrease
- **KATY:** We have not explored this issue.

79. Do you plan to model the effect of the congestion pricing system on regional emissions, and if so, how?

- **FHWA:** NEPA has already been done for the Capital Beltway, and has not been done yet for the I-95/I-395. Not planning any air quality evaluation beyond that (outside of the DC MPO modeling.)
- **KC:** N/A
- **MDOT:** Not now
- **ACCMA:** RTP included this project in overall air quality modeling. Air quality impacts were not separated for the Express lanes.
- **CALTRANS:** A 2007 MTC Study found some expected improvement in air quality, with a 3% decrease in NOx, 10% reduction in PM10, and 7% reduction in CO2.
- **ODOT:** Probably not
- **ST:** No
- **MacGregor:** Not yet
- **KATY:** That would be a question for our MPO.

Use of Revenues

80. Will the revenues be sufficient to operate and maintain the priced corridor?

- **FHWA:** Not immediately, but in the long term. The signed lease will likely be for 99 years.
- **KC:** The revenue from the first 2 toll lanes is expected to fund the building of 4 additional toll lanes.
- **MDOT:** Probably, otherwise MDOT would not have approved project
- **ACCMA:** Expected: Yes, plus some left over
- **CALTRANS:** Covered in 2007 study. Full time tolling would generate some excess revenue, part-time tolling would not be enough. Tolling objective: to maximize throughput, not revenue.
- **ODOT:** We might not generate more revenue than now, but we will prevent future loss of revenue.
- **ST:** Probably not, money will need to be allocated from state budget
- **MacGregor:** For the most part

- **KATY:** Recommend you contact John Tyler (832) 601-7870 with Harris County Toll Road Authority for these questions.

81. What policies or laws are in place regarding the disbursement of revenues from congestion pricing?

- **FHWA:** “Reasonable return” is expected to go to the private partner, while “excess revenue” will go to transit and incentives for carpools, other alternatives to SOV (title 23 eligible anywhere in the state.)
- **KC:** Not set in stone, currently under development.
- **MDOT:** Yes, all revenues must go through the Authority’s bond holders, who decide the disbursement. All funding goes into Authority’s general budget
- **ACCMA:** Must be spend in the corridor
- **CALTRANS:** Decided by the region. In San Diego Express Lanes revenue helps fund Express Busses.
- **ODOT:** Not in place yet
- **ST:** None yet
- **MacGregor:** Those contributing get excess revenues
- **KATY:** HCTRA is our local tolling authority

82. Will any changes to laws and regulations be required to facilitate the disbursement of revenues from the congestion pricing programs?

- **FHWA:** Not likely
- **KC:** Did not ask this question
- **MDOT:** No
- **ACCMA:** Already authorized by the legislature
- **CALTRANS:** Changes to the state legislature will have to be involved to provide a framework vision. The region will have a lot of say in how the money actually gets spent.
- **ODOT:** The Taskforce has considered using the revenue from congestion pricing for corridor improvement. Using revenue for transit has not been considered.
- **ST:** Possibly, because current laws indicate that revenue will go back into government budget
- **MacGregor:** No, everything in place
- **KATY:** N/A

83. How will the revenues from the congestion pricing program be used?

- **KC:** Not set in stone yet, mostly to build the full 6 toll lanes, O&M.
- **MDOT:** Funding goes back to Authority, some will be used for transit

- **ACCMA:** O&M; Construction of other HOV/HOT facilities on the corridor; transit on the corridor
- **CALTRANS:** Some of it for California HP enforcement
- **ODOT:** Not decided
- **ST:** Doesn't Know
- **MacGregor:** Organizations can use it on transportation related functions
- **KATY:** N/A

p) Will excess revenues be used to support transit on the corridor?

- **FHWA:** Likely, there is already transit using the corridor. It is up to the state of Virginia.
- **KC:** N/A
- **MDOT:** Yes
- **ACCMA:** Yes
- **CALTRANS:** Likely; a lot of demand for more rail in the Bay Area—commuter train and BART expansion
- **ODOT:** N/A
- **ST:** Doesn't Know
- **MacGregor:** N/A
- **KATY:** N/A

q) What percentage of revenues will be used outside of the corridor?

- **FHWA:** N/A
- **KC:** N/A
- **MDOT:** Doesn't Know
- **ACCMA:** Zero
- **CALTRANS:** Unknown at this point
- **ODOT:** N/A
- **ST:** Doesn't Know
- **MacGregor:** However much you put in is what you get back
- **KATY:** N/A

84. What has been the public reaction to the proposed revenue disbursement scheme?

- **FHWA:** Not aware
- **KC:** Have not tested. During public forums, recommendations for transit were present.
- **MDOT:** Public wants to see more money go into transit
- **ACCMA:** Ok, as long as the revenue stays in the corridor
- **CALTRANS:** Not sure-could look at the I-680 study
- **ODOT:** Not discussed.

- **ST:** N/A
- **MacGregor:** None
- **KATY:** N/A

85. What are the most acceptable ways to use congestion pricing revenues?

- **FHWA:** Not aware
- **KC:** To improve service on the corridor.
- **MDOT:** Putting money into transit
- **ACCMA:** N/A
- **CALTRANS:** Did not study
- **ODOT:** Not discussed. Mostly focused on per-mile charge so far.
- **ST:** N/A
- **MacGregor:** Put revenues back into the facility
- **KATY:** N/A

86. In what new ways might revenue from congestion pricing be spent?

- **FHWA:** N/A
- **KC:** Funding corridors that access I-75
- **MDOT:** N/A
- **ACCMA:** Cross-corridor subsidies are not allowed by the current legislature.
- **CALTRANS:** Did not ask this question
- **ODOT:** Not discussed. Would have to be revisited.
- **ST:** N/A
- **MacGregor:** Maintenance, capital costs for expansion, occupancy, and enforcement
- **KATY:** N/A

Conclusions

87. Are there any additional comments you would like to make at this time?

- **FHWA:** Some info on the following website:
<http://www.virginiahotlanes.com/beltwayproject/index.html>
- **KC:** Additonal info: www.swfea.net
- **MDOT:** There are other projects to add congestion priced lanes to current interstates
 - Gave names of two others to contact about this project
- **ACCMA:** Anything new presents a big challenge. Congestion has to be significant for people to be willing to pay.
 - Would like a copy of the final report e-mailed to jhart@accma.ca.gov

- **CALTRANS:** None
- **ODOT:** None
- **ST:** Lots of information on wsdot.wa.gov (search for HOT and find link to project),
 - Suggested contacting project manager Patty Rubstello 425-450-2720
- **MacGregor:** More projects in this field are needed, more examples
- **KATY:** None

Form 3 Interview Results – Entities with Non-Congestion Priced Tolling Facilities

Interviews were conducted with four transportation professionals about various reasons that congestion pricing projects were not implemented or considered in Florida, Pennsylvania, and Texas.

The respondents to the questionnaires had spent an average of 18 years (range 10 – 26 years) at their current employer, have an average of 23 years (range 15 – 31 years) experience in the transportation field and an average of 6 years experience with congestion pricing. The responsibilities of the respondents in their respective projects were varied. They include research and advisory roles, financial analysis, and implementation. The roles of the respondents' employers were, for the most part, state DOTs; however, some respondents had previous experience in congestion pricing outside their current employer.

In some instances, not every interviewee provided a response to certain questions due to not knowing the answer or non-applicability to their particular situation. The following report provides a summary of the responses obtained for each of the interview questions.

The answers in this section are grouped by state. It should be noted that there were 2 respondents from Florida, one from Pennsylvania, and one for Texas. Below there is a brief summary of each of the sections of questions, followed by the detailed answers.

Form 3 - Section Summaries

1. Program Description

Many different strategies were considered among respondents, including: pricing some lanes, pricing all lanes, building new roads, building toll lanes within the interstate median, fully electronic toll collection, and a variety of managed lane systems (HOV, HOT, Express Toll, BRT & TOT in combination with HOT (shared ROW with SOVs).

2. Obstacles to Congestion Pricing

Several of these projects had similar impediments. Some of the obstacles implementing congestion pricing in these areas were lack of sufficient funding, lack of political support, finding champions within the organization, public's perceived equity issues, and a general lack of public understanding about congestion pricing. Specifically, in Pennsylvania, focus groups showed that commuters would not change their driving habits, even with significant surcharges. Additionally, commercial drivers simply could not change their schedules, surcharges or not, so there would be no benefit.

3. Public Acceptance of Congestion Pricing

As mentioned above, there was a lack of public understanding about congestion pricing. In order to attempt to gage the level of acceptance, all organizations reported using a combination of focus groups and surveys. Some surveys were mailed while others were done via telephone.

Some of the information gathered in Florida was that people would prefer a free road. People generally prefer a set rate instead of variable pricing. Concerns are often raised by "interest groups" and not the actual people affected— lower-income groups who are often advocated for actually support projects because they have a high value of time (harsh consequences for being late for a job). In Pennsylvania, focus groups reported that users "want to go when they want to go." And so the surcharge was not enough to change behavior. Texas focus groups took issue with "having to pay for something that was once free." Also, they were afraid of the "uncertainty" (i.e. it's \$1 now, how much will it be in 15 minutes?).

In terms of public outreach tools, in Florida, powerpoint presentations and videos for I-75 expressway were shown to public/elected officials. There were also promotional TV ads, fliers, radio spots, appearances on public TV, ads on truck panels. They found that their open houses in public places (like malls) tended to be more effective than those held at official locations and at set times.

4. Policy Tools

No lobbying efforts had been put into practice by any of the respondents.

As described above, focus groups, meetings and presentations held in Florida, but no other areas reported any major public outreach.

In terms of required changes to policy, in Florida, statutory changes and legal clearance is required. Currently only a uniform toll rate allowed, this needs to change for variable pricing. Also, congestion pricing has to fit within an agency's existing policy framework – HOV conversion that provides buses with priority is an example of how CP policy can fit within transit agency. In PA toll schedules would have to be revised; right now it is just a flat rate throughout the system. In Texas there is the Value Pricing Pilot Program, there can be no user fees unless you've completed this.

5. Technology Deployment

For toll collection, Florida is currently replacing the toll collection system. They are moving to Express Lanes with Open Road Tolling. This will cost \$200+ million. SunPass was introduced in 1999, and since then 60% of toll road users have switched to SunPass. Cash toll payment still available. Similarly, in PA they are already using EZ Pass. The software would just be changed to reflect surcharge and/or discount. Those without pass pay cash at plaza. In Texas, there is electronic toll collection, transponders/video, and Toll Tags.

None of the respondents have developed technology to detect vehicle occupancy yet.

For enforcement, Florida is working on improving video technology and also using visual monitoring. Pennsylvania and Texas are still working on the enforcement piece. Texas says it does not plan on having any "man" stations along the corridor.

6. Effects of Congestion Pricing on Land Use

In Florida they expect increased levels of access increases land prices. However, they do not believe this conversion would have enough of an impact on behavior/trip patterns to impact home and work locations. Pennsylvania projects that if traffic through-put could be increased, fewer interchanges and off-ramps would be needed. Texas believes that there will be no direct effects on land use. No modeling has been done in any of these locations.

7. Effects of Congestion Pricing on Air Quality

Florida and Texas report that they see positive effects on air quality, although substantial emissions. Modeling has not been done. Pennsylvania has not discussed air quality.

8. Use of Revenues

All respondents report that revenues would have to stay in the region, mostly going back to that specific project.

Form 3 - Detailed Responses

About Respondents

*Two interviewees did not answer these questions

1. How many years have you been at the agency (or university, etc.)?

- **PA:** 26 years
- **Florida:** 10 years

2. How many years of experience do you have in transportation?

- **PA:** 31 years
- **Florida:** 15 years

3. In congestion pricing?

- **PA:** 5 years
- **Florida:** 7 years

4. What is your role/responsibility in congestion pricing?

Responses included:

- Studying its feasibility for the Philadelphia and Pittsburgh regions
- Studying. Need to move to congestion pricing in the next 10 years.

5. What is your agency's role in the region? What geographic area is your agency responsible for?

- Transportation planning for the region. 11 counties, 460 miles of Turnpike system.
- Responsible for the PA Turnpike, throughout the state.

Program Description

The programs considered included different methods of lane pricing, various managed lane strategies (HOT, Express), variable pricing on toll roads, and the possibility of building more lanes.

6. What types of congestion pricing programs have you considered?

Florida:

- Pricing specific lanes
- Pricing all lanes
- Building a new toll road/turnpike
- Building toll lanes within the interstate median-usually limited space available

- Fully electronic toll collection
- Managed Lanes: HOT, Express toll, BRT & TOT in combination with HOT (shared ROW with SOVs)

PA:

- Five years ago, considered trying to reduce congestion during peak hours in the Philadelphia and Pittsburgh areas by introducing peak-hour surcharges and/or toll discounts to EZ Pass users.

TX:

- Value pricing on new lanes
- Transit discount prices for toll lanes
- Variable pricing based on LOS

Obstacles to Congestion Pricing

While funding was mentioned as an obstacle, the primary factor across all states was the public perceptions and the lack of public information available.

7. What do you see as some of the biggest obstacles to implementing a congestion pricing mechanism?

Florida:

- Funding (more possibilities in 2012)
- Creating a fully electronic toll collection system and upgrading the currently used toll collection technology
- Political opposition
- Technology is not the problem anymore; public perception (big one right now) and finding internal champions are newer challenges.
- Public's perceived equity issues, which tends to go away after implementation; really a matter of the public understanding the concepts up front
- In mid- to late-90s, the problem with finding internal champions (within DOT and other transportation agencies) was lack of understanding – they were too busy with other projects
- Issues at the political level with negative connotations of “tolling” and allowing SOVs in HOV lanes
- Once early congestion pricing projects were operational, it became easier to find internal champions and political supporters – but it is still difficult because it is easier to campaign against it than for it; it's also easy to say “that won't work here”

PA:

- Resistance of the public and commercial drivers/receivers.

- Focus group showed that commuters would not change their driving habits, even with significant surcharges.
- Commercial drivers simply could not change their schedules, surcharges or not.

TX:

- Public information—there are no current toll lanes/roads

Public Acceptance of Congestion Pricing

8. Have you collected information on public acceptance on congestion pricing? What methods were used?

Florida:

- Some surveys and a simple question: Do you want to pay tolls for new capacity. Positive responses received.
- Surveys - not the best method and actually counterproductive to release results because they automatically elicit a negative response – respondents cannot be educated
- Focus Groups – successful because participants do not need prior knowledge of the project to answer initial questions, but then provide information and education and re-test the ideas (several months later)
- Citizens' Jury (Minnesota) – 5 days of discussions, repeated in 2002 with a different panel (talk to Ken Buckeye for more information) – led to “opinion leaders” who went back to their communities

PA:

- Yes, focus groups conducted by Wilbur Smith. Also, a survey was available online and passed out at some toll plazas.

TX:

- Phone surveys
- Focus groups

9. If so, what were the major concerns that the public raised?

Florida:

- People prefer a free road. Generally prefer a set rate instead of variable pricing
- Concerns are often raised by “interest groups” and not the actual people affected – lower income groups who are often advocated for actually support projects because they have a high value of time (harsh consequences for being late for a job)

PA:

- Users “want to go when they want to go.” The surcharge was not enough to change behavior.

TX:

- Having to pay for something that was once free.
- Being afraid of “uncertainty,” i.e., it’s \$1 now, how much will it be in 15 minutes?

Have you prepared any public information materials related to congestion pricing?

Florida:

- PowerPoint presentations and videos for I-75 expressway shown to public/elected officials.
- Promotional: TV ads, fliers, radio spots, appearances on public TV, ads on truck panels (talk to Stacey)
- Educational: Open houses in public places (like malls) tend to be more effective than those held at official locations and at set times; mass mailing

PA: No. Only studied the feasibility of pricing.

TX: Not at the district level

10. Do you foresee potential differences in levels of acceptance based on demographics?

Minnesota:

- Active account users seem to be balanced across demographics that are using the free facilities
- Higher income uses accounts more often
- Fairly balanced opinion – lower income like to have it as an “insurance policy”

Colorado:

- Had to be careful about balancing the needs of SOVs, BRT, etc.

PA:

- Only recorded notable difference was in attitudes between Philly and Pittsburgh. In Philadelphia people were more in favor of the idea (even if it would not change habits).

TX: Lower economic areas will be less accepting

11. In what areas do you think that acceptance will differ?

N/A

12. Which pricing strategies do you believe will be most widely supported? Most widely criticized?

Florida:

- Congestion pricing is likely to be less acceptable.
- Once they are up and running, HOT lanes will be widely supported, especially if they are conversions from HOV and can demonstrate transit benefits

PA:

- No real difference with commuters. However, commissioners sharply criticized both.

- Saw surcharge as penalizing their regular customers.
- Saw EZ Pass discount as bad due to the large investment that had just been made to implement this system (more on this in conclusion).

TX:

- Set rate for peak periods will be supported.
- Variable will be criticized.

Policy Tools

13. Has your agency engaged in any public relations or lobbying efforts related to congestion pricing?

Florida:

- Not yet
- Need to fully explain projects to agency heads and politicians before reaching out to the public

PA: No, only studied the feasibility of congestion pricing.

TX: No lobbying. Just focus groups and phone surveys

14. Has your agency developed any public outreach programs related to congestion pricing?

Florida:

- Specific congestion pricing project on I-75 in SW Florida, with Expressway Authority already created by the State Legislature.
- Focus groups, meetings and presentations held.

PA: No

TX: Not yet, but highly recommended

15. What transportation policies would need to be changed in order to implement congestion pricing?

Florida:

- Statutory changes required: currently only a uniform toll rate allowed, need to change for variable pricing.
- Legal clearance needed for:
 - Prohibitions on tolling
 - Ability to enforce tolls
 - Occupancy restrictions for HOV lanes
 - Video enforcement

- Policy changes: Congestion pricing has to fit within an agency's existing policy framework – HOV conversion that provides buses with priority is an example of how CP policy can fit within transit agency

PA:

- Toll schedules would have to be revised. Right now it is a flat rate throughout the system.

TX:

- Value Pricing Pilot Program—no user fees unless you've completed this
- Laws—Texas cannot convert free lanes to paid lanes

16. What about other policies (fiscal, taxation, etc.)?

FL: Only the toll authority change mentioned above

PA:

- The Turnpike's "Trust Indenture" was already revised in 2001 to allow potential congestion pricing. Previous wording did not allow for variances in the toll. It was made more flexible to accommodate potential future congestion pricing. So, there would be no barriers to the pricing, even though it does not exist.

Technology Deployment

17. Have you investigated any technologies associated with congestion pricing in the areas of toll collection, vehicle occupancy determination, and enforcement?

Florida:

Toll Collection:

- Currently replacing the toll collection system in Florida. Moving to Express Lanes with Open Road Tolling will cost \$200+ million.
- SunPass was introduced in 1999, and since then 60% of toll road users have switched to SunPass. Cash toll payment still available.

Vehicle Occupancy:

- Technology considered, no currently ready and available technology. I-95 (South Florida) Express Lanes project-considering various technology.

Enforcement:

- Will continue to enhance video enforcement, add ANPR.

Minnesota:

Toll Collection:

- All electronic.

- With the addition of dynamic & time of day tolling to a traditional toll road, may need to continue with cash tolling temporarily (as with Toronto's 407)
- Transponder seems to be very effective (read/write transponders are necessary in MN because of enforcement technology – officers “communicate” with transponders)
- Other option: sticker tags

Vehicle Occupancy:

- Infrared is not accurate enough
- Visual observation to date
- Australian firm – finger print card

Enforcement:

- SR-91, I-25 use license plate capture and then mail-in citations – this required enabling legislation
- MN's HOT is non-barrier separated, but has 5 or 6 entry/exit points – cop can “zap” a transponder with mobile equipment and read it – checks whether there was a valid transaction since the last entry point

PA:

Toll Collection:

- Already using EZ Pass – software would just be changed to reflect surcharge and/or discount. Those without pass pay cash at plaza.

Vehicle Occupancy:

- Tolls were not to be based on this. Not looked into.

Enforcement:

- Again, only studied the feasibility. Didn't get far enough to consider what additional enforcement might be necessary.

TX:

Toll Collection:

- electronic toll collection
- transponders/video
- Toll tags (inoperable across states)

Vehicle Occupancy: not yet

Enforcement:

- not planning any “man” stations along corridors

Effects of Congestion Pricing on Land Use

18. What effects would you expect congestion pricing to have on local and regional land use?

Florida:

- Access increases land prices
- Conversion – would not have enough of a change in behavior/trip patterns to impact home/work locations
- SR-91 added capacity and experienced huge time savings – Riverside County has taken advantage of it and sold more houses (thus more sprawl)

PA: If traffic through-put could be increased, less interchanges and off-ramps would be needed.

TX: Only adding lanes, no direct effects on land use

19. Have you ever modeled the effect of the congestion pricing system on regional land use?

FL:

- Land use planning is done by local county officials, and is an input for the regional transportation models.
- Turnpike Enterprise does not do any land use modeling.

PA: No

TX: No

20. What modeling do you currently use to predict changes in travel demand?

FL:

- State Model
- Multi-county regional transportation models.

PA: Not sure – that is more the realm of the traffic engineers and outside consultants (Wilbur Smith, Vollmer Assoc.)

TX: On toll lanes only

21. Are the travel demand modeling tools capable of predicting the impacts of congestion pricing on land use?

Florida:

- Not capable of incorporating congestion pricing
- With traditional metro models, can simulate by changing impedances
- AECOM Enterprises – impacts of variable tolls
- Follow-up with Ashley Yelds

TX: Yes, they're capable for tolls, but not congestion pricing

Effects of Congestion Pricing on Air Quality

22. What effects do you expect congestion pricing to have on air quality?

Florida:

- Going to fully electronic tolling system will likely improve the air quality. Congestion pricing not evaluated for air quality impacts.
- Has to be a substantial addition of capacity – regardless will experience increases in some and decreases in other (with speed changes)

PA: This was discussed conceptually, but not the concern of the study

TX: Positive effects- encourages car pooling and decreased travel during peak travel times

23. Have you ever modeled the effect of the congestion pricing system on regional emissions?

Florida:

- Performed an estimate for full electronic tolling system.
- Developing a better model that would be 24-hour based.

PA: No

TX: No

24. What modeling tools would you use to predict the impacts of congestion pricing on emissions and air quality?

Florida:

- 4-period model: incorporated AM Peak, Mid-day Travel, Evening Peak and Nighttime Travel.

PA: Don't know

TX: MPO does this

Use of Revenues

25. What policies or laws are in place regarding the disbursement of revenues from congestion pricing?

Florida:

- Currently no legislature or guidelines. Revenue goes into the Florida Turnpike system. I-94 project: talk about supporting transit.
- I-25: FTA funding in original HOV lane funding, which came with certain requirements – no detrimental impact to transit use; legislation in '99 required that funds be spent on the corridor

MN: also designed for that (transit) purpose

PA: The Trust Indenture

TX: Any surplus funds must stay in the region

26. Will any changes to law and regulation be required to facilitate the disbursement of revenues from the congestion pricing programs?

Florida:

- Turnpike Enterprise would like to see the legislature remain unchanged (have control over the revenue.)

PA: No

TX: Already put in place

27. What would be most acceptable ways to use congestion pricing revenues?

Florida:

- Pressure for funds to remain on the corridor, particularly for transportation projects
- For conversions, there is a push for use of revenues for transit (improvements or expansion)
- Other related improvements – like direct access ramp to park & ride lot – basically use of revenues to directly improve service for existing and new users

PA: Put them back into the Turnpike system for improvements.

TX: Should go along with how the corridor was financed

28. Would the public support the use of revenues to support transit on the corridor?

Florida: There is no transit on the corridor currently.

PA: Yes

TX: Yes, transit

- Bus
- Rail

29. Would the public support the use of revenues outside of the corridor?

Florida: Yes, for new roadways and transit

PA: No.

- Look at the uproar over the proposed toll on I-80 to provide funds for infrastructure repairs.
- Local users feel they would be subsidizing the rest of the state.

TX: If it helps the region and follows local decisions

30. In what other ways might revenue from congestion pricing be spent?

Florida: Building I-95 Express lanes in Miami

PA: Don't Know

TX: Long range plan—must stay within the area

Conclusions

31. Are there any additional comments you would like to make at this time?

At the time of the congestion pricing study, the EZ Pass system had recently been put in place and was quickly reducing congestion at the toll plazas (by a factor of 3 where market penetration reached 70%). Congestion pricing was therefore seen as redundant.

Congestion is no longer seen as a major concern (due to EZ Pass), but if it were, congestion pricing might be considered again (or if it were mandated by law, but that has so far been unsuccessful). At the present time, the rising price of gas seems to be doing a good bit to change driving behavior.

Congestion Pricing Response

Section III: Demographic/Travel Profiles



Produced for
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Congestion Pricing Response

Section III: Demographic/Travel Profiles

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Congestion Pricing Response

Section III: Demographic/Travel Profiles

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Congestion Pricing Response

Section III: Demographic/Travel Profiles

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A Geographic and Demographic Profile of Morning Rush Hour Commuters on Highways in North Metropolitan Atlanta

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Executive Summary

During summer 2006, license plate data on morning rush hour commuters were collected to assist in creating a potential participant pool for the congestion pricing phase of the Commute Atlanta instrumented-vehicle study. The Commute Atlanta study needed to identify census block groups with the highest probability of yielding study participants eligible for recruitment. Approximately 17,000 unique vehicle registration addresses in a six-county area were obtained from the license plates of vehicles observed traveling on several metropolitan Atlanta highways. The data collection enabled further geographic and demographic analysis of rush hour commuters at the census blockgroup level, providing new insight on limited-access highway commuters' characteristics and demographic characteristics such as census blockgroup income distribution, travel mode, and travel times of the highway-based commuters who contribute substantially to the region's traffic congestion and worsening air quality.

Observation sites were located near the intersections of radial highways and a "perimeter" highway encircling Atlanta at a 10-12 mile radius from the downtown Central Business District. On average, commuters registered their vehicles (and presumably lived) 13 miles from the observation sites. The registration addresses were located on average 4.2 miles from the centerlines of the highways on which they were spotted. Demographically, highway commuter households had incomes 14.4% higher than the average household, though this percentage varied by observation site. They were less likely to carpool or utilize non-automobile forms of transportation on their journey to work, but were more likely to work at home. Highway commuters were also more likely to report longer travel times to work than their neighbors in the census survey. These findings have implications for congestion pricing and related equity concerns.

Introduction

As congestion and travel times have increased in many parts of the country over the years, particularly urban areas, transportation planners are increasingly looking towards solutions to improve the efficiency of existing transportation facilities rather than adding expensive capacity to those facilities to satisfy peak hour demands. Economic incentives and disincentives such as value pricing strategies can be used to prudently manage travel demand among various groups of facility users. Congestion pricing, or implementing a fee for use of selected facilities during times of heavy demand, is lauded by economists and the transportation community as a way to monetize the externalities associated with congestion while potentially generating revenue for further transportation system improvements. Congestion pricing on high-volume transportation facilities can have positive impact on regional traffic operations as well as environmental and quality of life considerations; however, strong public opposition to tolls can preclude implementation, even as congestion and pollution worsen. Objections may range from philosophical objections to paying for what some perceive as a free public good, to objections associated with the perception that tolls will unfairly impact lower-income households.

To address equity concerns when evaluating potential value pricing projects and, further, to shed light on public willingness-to-pay, it is important for transportation planners to understand who is likely to be affected by these projects. This study examines the geographic and demographic characteristics of morning rush hour commuters on specific highway facilities via direct observation of individual vehicles. Realizing the geographic extent of a highway commutershed helps to determine a facility's potential "attractiveness" and impact on the local road system. The demographic profile of commuter households within this commutershed can be used to bolster or challenge arguments for implementation of specific pricing or managed lane projects on overburdened transportation facilities.

Methodology

Purpose and Scope

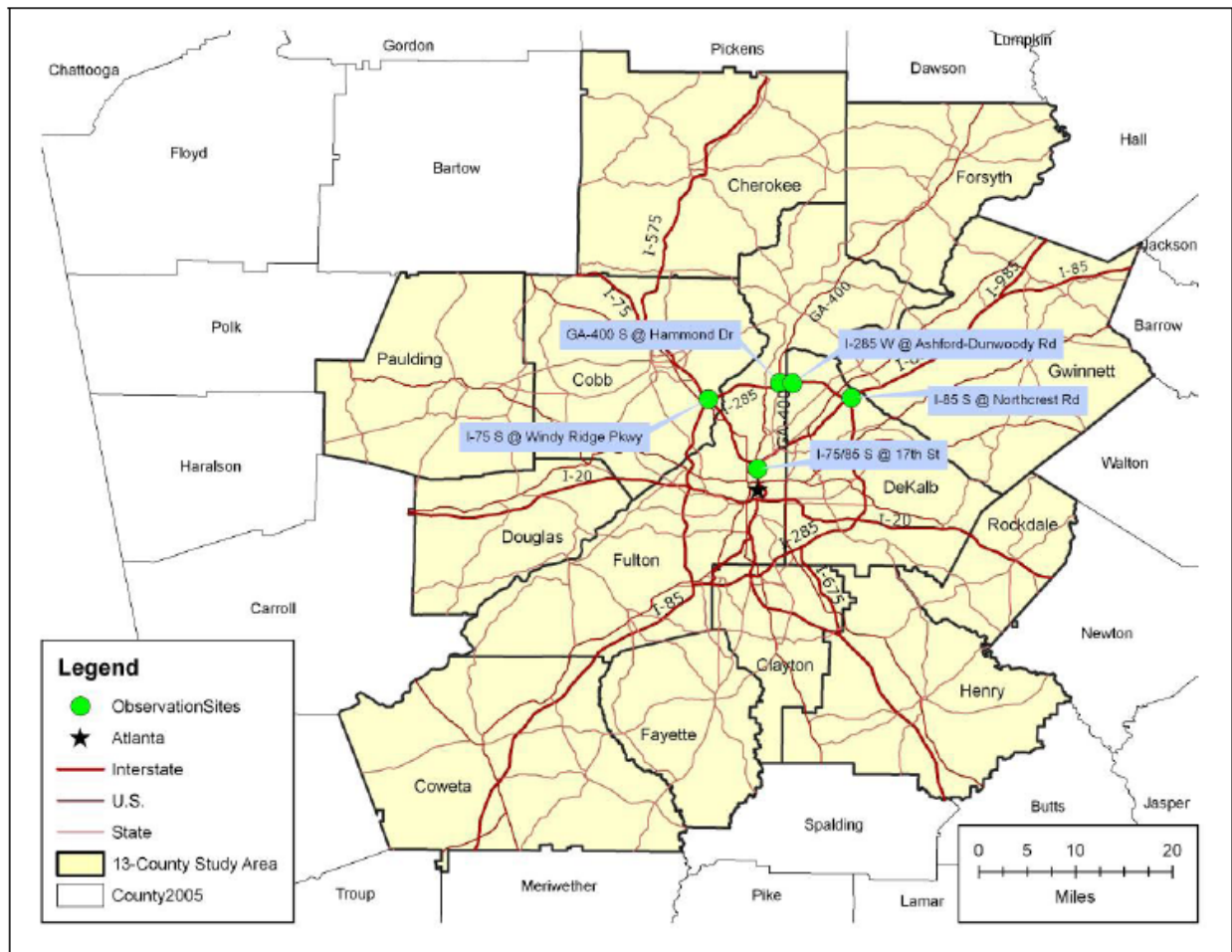
In the summer of 2006, the Commute Atlanta research team began the process of identifying new participants for the 13-county Metropolitan Atlanta non-attainment area for Phase III (real-time congestion pricing on freeway commuters) of the Commute Atlanta study. The Commute Atlanta Value Pricing research, funded by the Federal Highway Administration (FHWA) and the Georgia Department of Transportation (GDOT), is designed to assess the effects of converting fixed automotive operating costs into mileage-based and congestion-based operating costs. Over the past three and half years, the Commute Atlanta project has collected detailed information on more than 1.8 million vehicle trips on approximately 475 vehicles from approximately 275 households. The prime candidates for this phase were solo drivers who utilized the highways frequently in a suburb-to-CBD commute pattern. Single

Occupant Vehicle (SOV) drivers were hypothesized to be sensitive to highway pricing mechanisms, in terms of modifying their departure times, than current carpoolers. Although the Commute Atlanta Phase II participants all lived within the metropolitan Atlanta area, many did not use the highways often enough to make them eligible for Phase III. Thus, the research team actively sought out new participants who were frequent highway commuters.

Data Collection Procedure

For five separate weeks during May, June, and July 2006, researchers collected the license plate characters of passenger vehicles (i.e., cars, SUVs, pick-up trucks, mini-vans, and conversion vans) observed traveling in the morning peak period direction on heavily congested highways in north Metropolitan Atlanta. The observation points were I-75 SB at Windy Ridge Parkway, GA-400 SB at Hammond Drive, I-85 SB at Northcrest Road, I-285 WB at Ashford-Dunwoody Road, and the I-75/I-85 “Connector” SB at 17th Street (Figure 1). Each site was observed for one week. Approximately one to one-and-a-half hours of data (always overlapping the 7:30 to 8:30 AM period of highest traffic volume) were collected daily on weekdays at each site, using overpasses as observation points.

Figure 1: License plate data collection sites for Commute Atlanta Phase III



From their overpass vantage points, researchers collected data on three general purpose travel lanes at each location using spotting scopes, voice recorders, and video recorders.¹ Vehicles traveling by High Occupancy Vehicle (HOV) and in the far right (weaving or exit) lanes were not observed, as solitary drivers were the focus of the investigation and vehicle movement near exit lanes made it difficult to accurately view license plates (A 2007 follow-up study, however, did collect data on vehicles in both HOV and general purpose lanes to provide a more detailed profile of commuters at six locations along a 36 mile stretch of I-85). License plate data for trucks, buses, and out-of-state vehicles were not collected as they were ineligible to participate in the Commute Atlanta study. While license plate characters could be obtained with the use of high-resolution video cameras and advanced image recognition software for long-term data collection efforts, this setup is very expensive and was not justified for this project.

For each lane observed, two researchers alternated reading the license tags seen through the spotting scope into a voice recorder. Because of the strenuous data collection conditions on the overpasses, researchers switched positions every 10 to 15 minutes. Video recorders were deployed and traffic counts

were conducted back in the laboratory as it was impossible to dictate all passing vehicles into the voice recorders. Field personnel collected approximately 500 license plate observations per hour per lane observed, which constituted 25 - 30% of hourly traffic volumes per lane observed, depending upon traffic volume. Given the large sample rates, no weighting of observations was necessary from a statistical standpoint.

Upon returning to the laboratory, the contents of the audio tapes were transcribed into spreadsheets listing license plate numbers, observation site characteristics, and intermediate time readings. In good weather conditions, data were collected daily for one week at each location. This resulted in 24 days worth of license tag numbers. Interstate 85 SB at Northcrest Road was observed Tuesday to Friday because it rained the preceding Monday.

For each observation period, vehicle registration addresses were processed, matched to census block IDs for each observation (unlinked to corresponding license plates to preserve confidentiality), and returned to researchers for geographic and demographic analyses of commuters using Summary File 3 of the 2000 United States Census. Vehicle characteristic data (i.e., make, model, model year, fuel type, etc) were also obtained from the license plate numbers, allowing researchers to form a detailed fleet profile of rush hour commuters for use in emissions and regional emissions modeling (1).

Sample Size

A total of 38,580 randomly sampled license plates were recorded in the field, 34,950 (90.6%) of which were unique, by site. Thus, approximately 10% of all vehicles were seen repeatedly at particular observation sites, indicating the presence of regular commutes during the morning peak time. This percentage was statistically consistent across all five sites. With longer observation periods and more consistent data collection times, it is likely that more repeat commuters would be observed. Binomial probability analysis, depending on the site and the number of lanes, indicates that between 10 and 15 % of vehicles would be seen repeatedly.

Over 3,000 vehicles were observed two or more times at a single site. Approximately 568 vehicles were seen at multiple sites during the data collection period (including one that was seen at three sites). There was an overall non-site-specific total of 34,382 (89.1%) unique license plates observed (Table 1). The majority of multi-site observations consisted of I-75, GA-400, or I-85 in combination with the I-75/85 Connector site closer to the Downtown Atlanta Central Business District (CBD). All of the former sites are 10-12 miles north.

Table 1: Total Number of License Plates Observed and Address-Matched

Site	License tags observed in field				License tags matched to GA vehicle registration database		
	Total	Unique	% Unique		Total	Unique	% Unique
I-285 WB @ Ashford-Dunwoody Rd	6,262	5,863	93.6%		4,859	4,475	92.1%
GA-400 SB@ Hammond Dr	9,075	8,142	89.7%		6,747	5,879	87.1%
I-75 SB @ Windy Ridge Pkwy	8,248	7,346	89.1%		6,327	5,457	86.2%
I-85 SB @ Northcrest Rd	6,209	5,608	90.3%		5,034	4,453	88.5%
I-75/85 Connector SB @17th St	8,786	7,991	91.0%		6,453	5,692	88.2%
Total, by site	38,580	34,950	90.6%		29,420	25,956	88.2%
Duplicate tags (seen at multiple sites)	-	568	-		-	538	-
Total, not site-specific	-	34,382	89.1%		-	25,418	86.4%

The 34,382 unique, non-site-specific license plates were matched to their vehicle registration addresses and then to census block. A 73.9% registration database match rate was achieved, resulting in 25,418 unique license plate/address combinations. Some reasons for the relatively low match rate (85% is more typical) include the accidental recording of out-of-state vehicles, the difficulty of correctly interpreting license plates on fast-moving vehicles, inaccurate data recording/transcription due to the effects of constant traffic noise on audio file quality, and potential errors in the registration database.

The 25,418 addresses were then geocoded to provide latitudinal and longitudinal coordinates. As a result of pre-existing information or standardization-related errors in the vehicle registration database, only 24,699 (97.2%) of addresses were able to be geocoded with address (24,424, 98.9%) or street level (275, 1.1%) accuracy, often the minimum accuracy level needed to assure a spatial match to the correct census blockgroups.

This study was designed to target inbound commuters to the downtown within the 13-county metropolitan area, only vehicle registration addresses within this geographic area were assigned to a census blockgroup for further demographic analysis. Because the I-285 WB @ Ashford-Dunwoody Road site was fundamentally different from the other four sites and much more likely to serve suburb-to-suburb commuters, vehicle registration addresses associated with it were not used in the final dataset(s) as they were not relevant to the Commute Atlanta study.

A map of the multi-county “base” (MCB) commuting area and major activity centers as defined by the Atlanta Regional Commission MPO(2) is shown in Figure 2. Defined along traffic analysis zone (TAZ) boundaries and major roads in parts of the metro area, the “base” corresponds to the general geographic area that regular inbound commuters (as observed at the four remaining overpasses) might realistically originate. Qualitative knowledge of local surface street patterns and capacities helped to define typical travel routes that would enable commuters to access highways north of observation sites. At a county comparison level, the geographic reduction also ensured that north Fulton and DeKalb were not

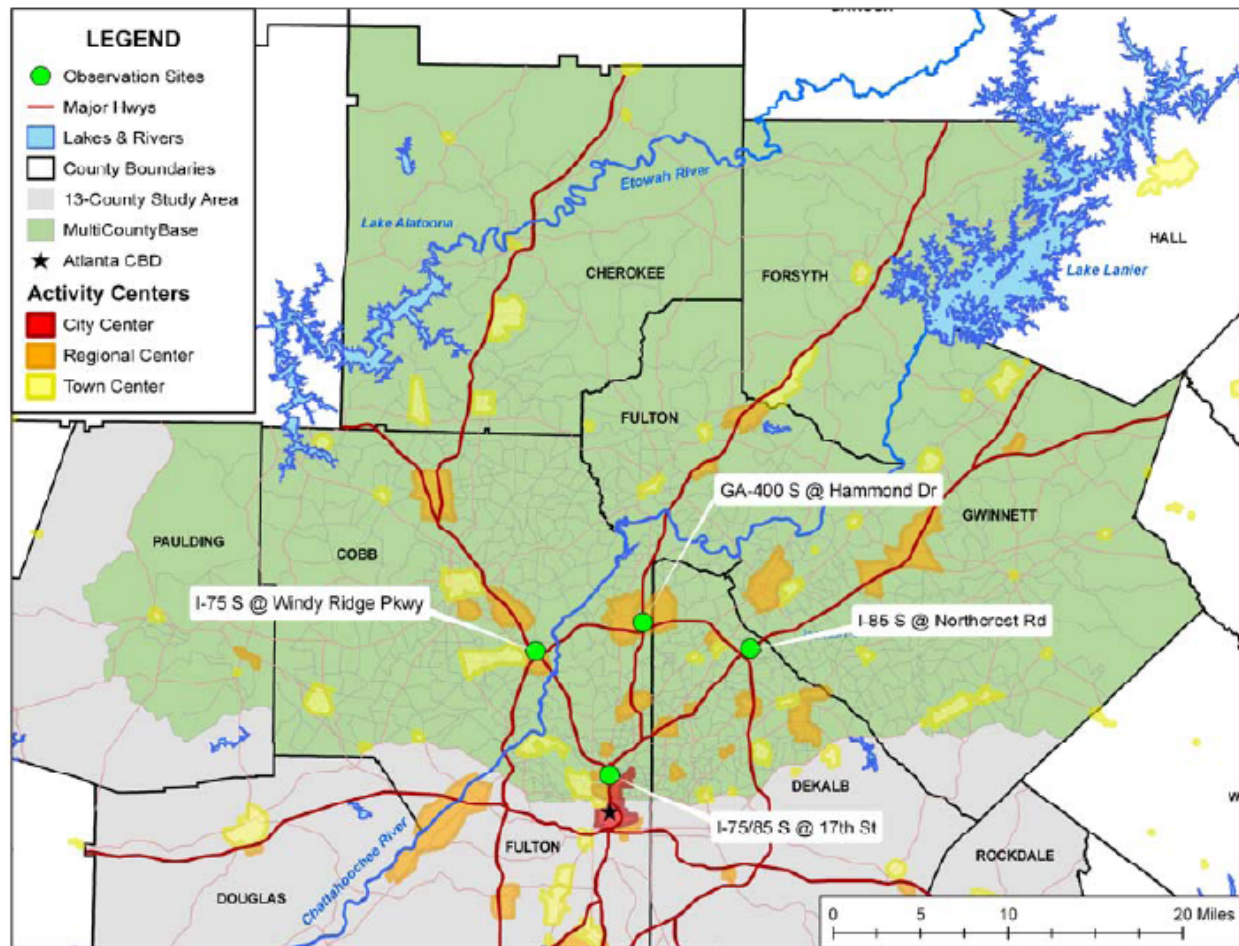
erroneously compared with south Fulton and DeKalb counties, respectively, which have very different demographic and income distributions from their northern neighbors. The size of the final dataset(s) is approximately 17,000 unique addresses corresponding to 20,137 license tag observations at four sites (Table 2).

Table 2: Number of License Tags Geocoded, Geographically Reduced, and Assigned to a Census Blockgroup²

	Vehicle registration addresses geocoded at address or street-level accuracy				Vehicle registration addresses geocoded and assigned to census blockgroup in geographically-reduced area		
Site	Total	Unique	% Unique		Total	Unique	% Unique
I-285 WB @ Ashford-Dunwoody Rd	-	-	-		-	-	-
GA-400 SB@ Hammond Dr	6,627	5,767	87.0%		5,770	4,952	85.8%
I-75 SB @ Windy Ridge Pkwy	6,047	5,217	86.3%		5,188	4,410	85.0%
I-85 SB @ Northcrest Rd	4,896	4,326	88.4%		4,115	3,605	87.6%
I-75/85 Connector SB @17th St	6,291	5,550	88.2%		5,064	4,405	87.0%
Total, by site	23,861	20,860	87.4%		20,137	17,372	86.3%
Duplicate tags (seen at multiple sites)	-	476	-		-	434	-
Total, not site-specific	-	20,384	85.4%		-	16,938	84.1%

Vehicles appearing at more than one observation site are double-counted in analyses that are disaggregated by site. 434 of the 568 vehicles that were seen at multiple sites were positively matched to a registration address in the Multi-County "Base" area. This should be taken into account when comparing data "totals".

Figure 2: Multi-County “Base” Map of Likely Commuter Universe with Activity Centers



As a result of the QA/QC process and geographic data reduction, the percentage of “repeat” observations within the analyzed dataset increased from 9.4% (see Table 1) to 13.7% in the final MCB area. Though diminishing the overall size of the dataset, this shift makes it more likely that the data analyzed corresponds to local commuters than to out-of-area visitors. The final data set used in the statistical analyses is represented by the right-hand side of Table 2. (Note: There is no way for the researchers to know actual origins and destinations of the vehicles). Some commuters are inbound to the downtown, some are commuters passing through downtown, some are inbound shoppers, some simply trips through Atlanta, etc. The Commute Atlanta study will target only inbound commuters in the telephone recruitment process when calls are placed to random households within target census blocks. Nevertheless, the demographic characteristics of the morning peak period freeway users, if they are suburb to downtown commuters or not, is relevant to the analyses undertaken in this paper and are critical with respect to the implementation of peak period pricing strategies that will affect all users during congested periods.

Geographic Analysis

County Origins

The registration addresses of observed vehicles were geocoded and analyzed by blockgroup and county origin. Vehicles were registered in 97.7% of the blockgroups identified as part of the MCB potential commutershed, with 867 of 887 blockgroups having at least one observation and over 500 blockgroups had fifteen or more observations.

Six North Metro counties accounted for 87% of the 29,420 matched vehicle registration addresses, while the top four of those (Cobb, DeKalb, Fulton, and Gwinnett) comprised almost 80% of all unique registration addresses. When geographically reduced from 13 counties to the likely commuter base, however, the distribution of county origins changed. The top three counties (Cobb, Fulton, and Gwinnett) comprised 82% of all observed registered vehicles, and are displayed individually in further demographic analyses (Figure 3).

Figure 3: County-Level Distribution and Sample Sizes of Vehicle Registration Addresses in the Likely Commute Universe (n = 20,137)

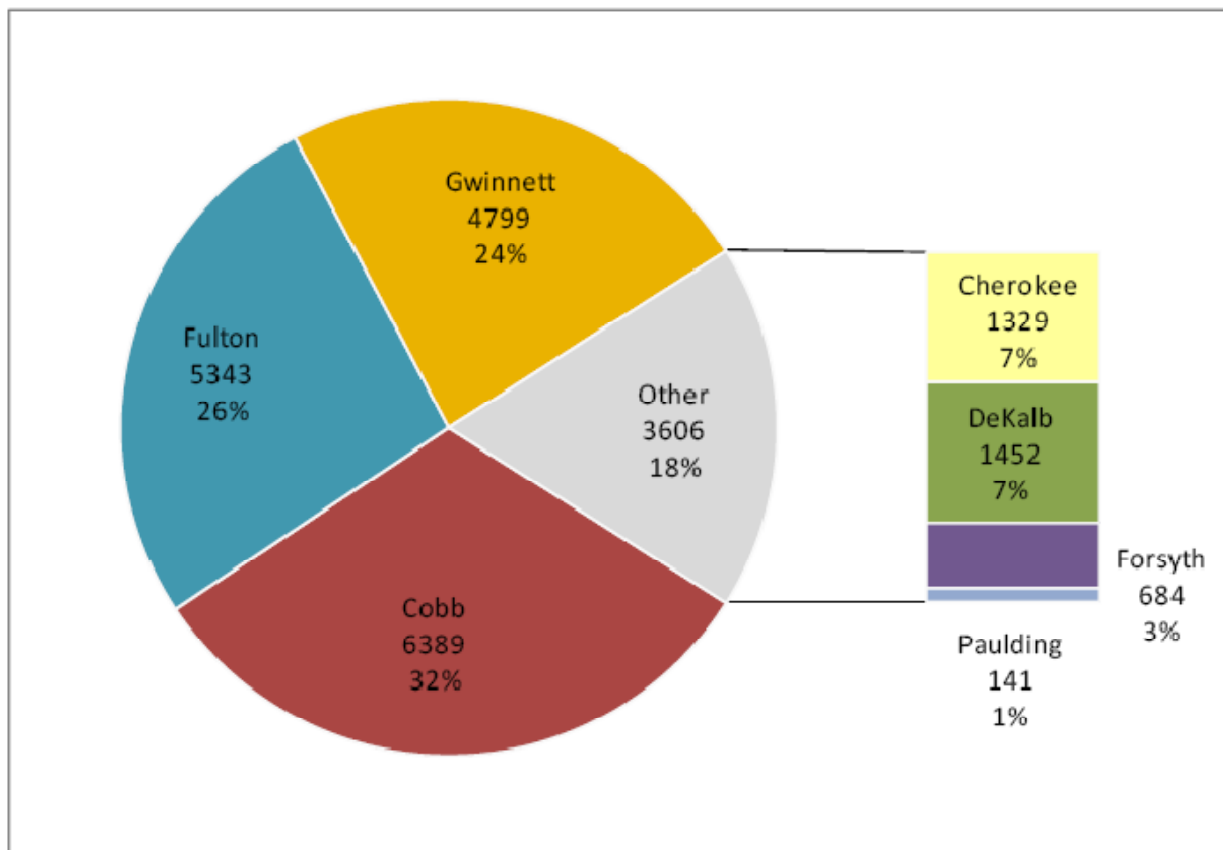
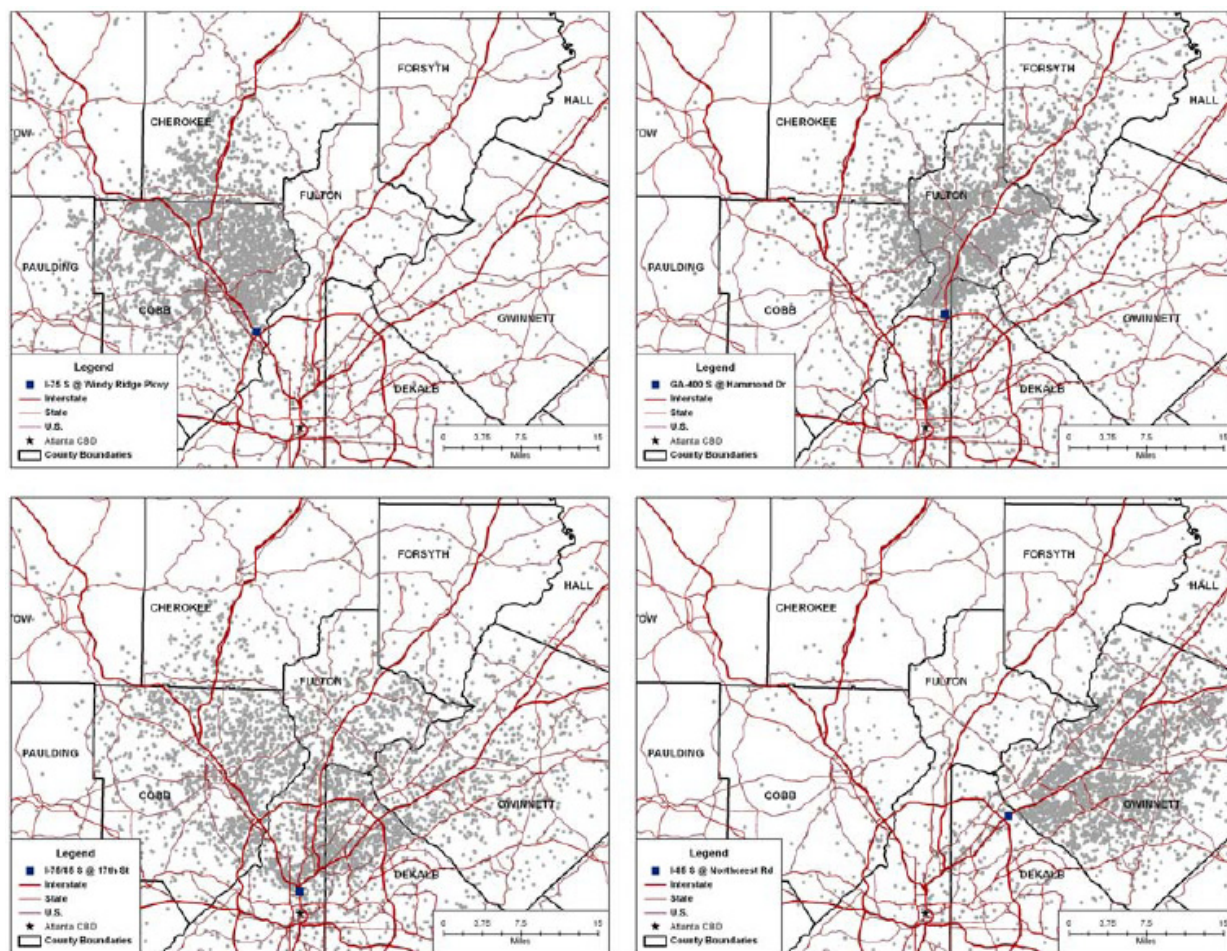


Figure 4 depicts the estimated commutershed for the four inbound observation sites. The map illustrates the approximate vehicle registration addresses for each of the observed southbound commute vehicles (mapped to the census block group). Figure 5 further defines commutersheds by the individual sites.

The map displays the Atlanta metropolitan area and surrounding regions in Georgia. Key features include:

- Legend:**
 - Observation Sites:**
 - GA-400 S @ Hammond Dr (Blue square)
 - I-75 S @ Windy Ridge Pkwy (Blue square)
 - I-75/85 S @ 17th St (Blue square)
 - I-85 S @ Northcrest Rd (Blue square)
 - Interstate:** Red line
 - State:** Brown line
 - U.S.:** Thin red line
 - Atlanta CBD:** Black star
 - County Boundaries:** Black outline
- Major Highways:** I-20, I-75, I-75/85, I-85, I-985, I-285, GA-400.
- Counties:** Gilmer, Lumpkin, White, Pickens, Cherokee, Forsyth, Hall, Jackson, Barrow, Gwinnett, Walton, DeKalb, Douglas, Cobb, Fulton, Polk, Macon, Valdosta, Savannah, Columbus, Athens, Augusta.
- Scale:** 0 to 20 Miles.

Figure 5: Commutersheds for Individual Interstate Observation Sites



Clockwise from top left: I-75 SB @ Windy Ridge Pkwy (n = 4,410),
 GA-400 SB @ Hammond Dr (n = 4,952), I-85 SB @ Northcrest Rd (n = 3,605)
 I-75/85 Connector SB @ 17th St (n = 4,405),

Though it is likely that most people reside at the locations where their vehicles are registered, there is no definitive way to determine where people were traveling from when they were observed during their morning commute. More than 10% of the address-matched Georgia-based vehicles were registered outside of the 13-county study area, a minimum of 30 miles (but usually closer to 50 miles) from Atlanta's Downtown CBD. One percent of vehicles were registered in cities over 100 miles away, such as Savannah, Augusta, Columbus, and Macon.

Previous research by Granell (2002) indicates that at least two-thirds of vehicles originate from the address at which they were registered, with higher percentages being observed within lower-density, higher-income blockgroups. (3) The trip purpose of individual vehicles observed traveling during the morning peak is also unknown, though data extrapolated from a regional household travel survey in 2001 show that over 60% of probable highway users during the peak time are traveling to work. This

percentage may be higher considering the physical and mental discomfort of utilizing highly congested routes for trips with more potential time flexibility (4). Based on these results, it is assumed that the majority of vehicles observed in this study are used by commuters.

More than 10% of observed vehicles were registered outside of the study area boundaries, however this may be more attributable to these vehicle registration addresses not corresponding to trip origins than to the presence of long-distance supercommuters. With respect to the region as a whole, the cost of living does typically increase with proximity to the Atlanta CBD. However, given the low and medium cost housing opportunities available throughout the metro area, housing costs are not likely to be the primary driver of residential choice. Many of the vehicles observed with non-study area registration addresses are likely being driven by metro residents who live closer in, but have not formally registered their vehicles in their primary counties of residence. In-state college students are likely culprits for this as are other people who have recently moved to the area from outlying regions. Personal relationships and use of company cars may also play a role. Potentially high insurance rates also contribute to avoidance of vehicle registration in the metro Atlanta area. More central areas of the city have relatively higher rates of vehicle theft and incidents than outlying ones, thus positively contributing to the cost of insurance billed using territorial rates (5).

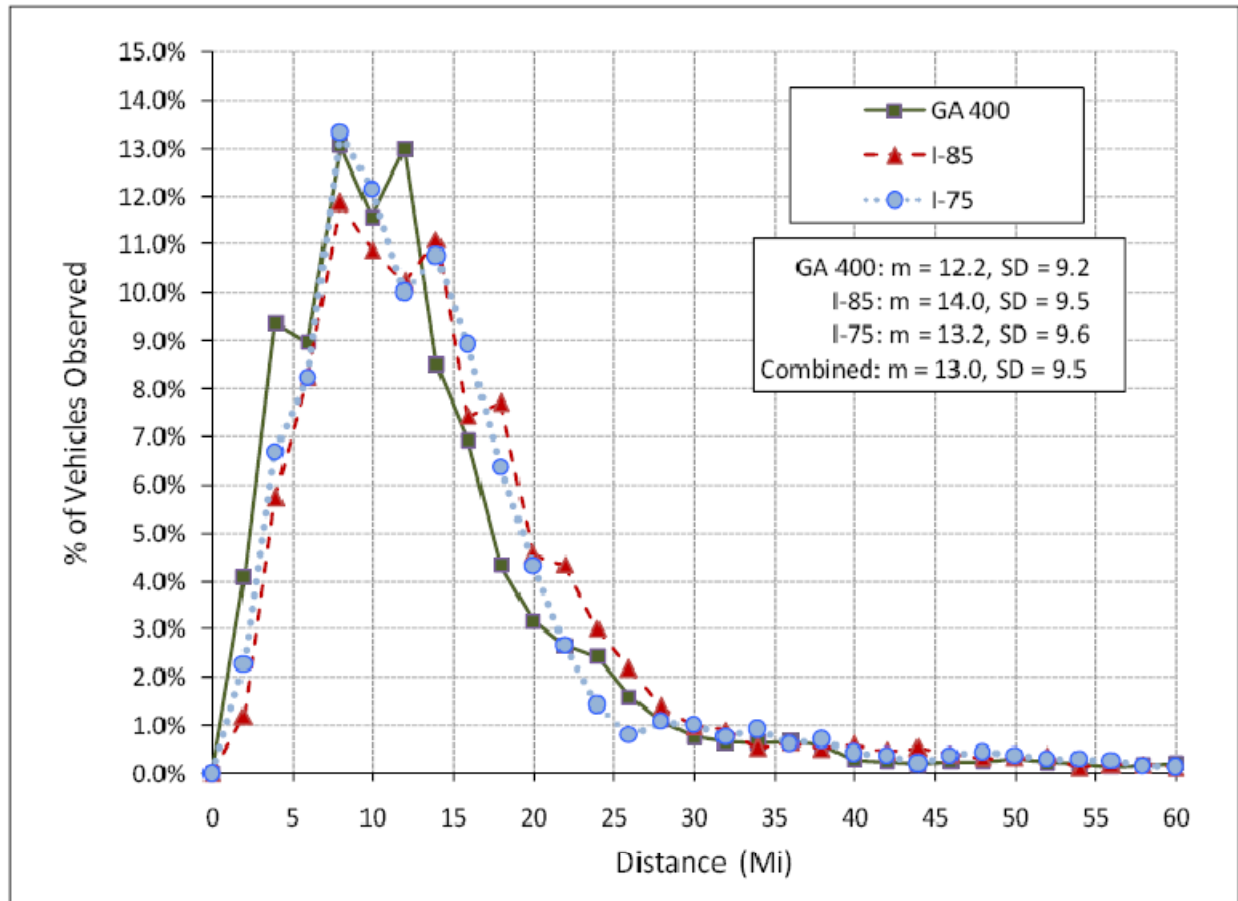
The commutershed diagrams indicate that commuters don't always use the highways that are physically closest to them, though they tend to do so much of the time. For the I-75 commutershed in particular, one would expect that many of the vehicles originating in east Cobb would be seen on GA-400 SB instead of I-75 SB. For several reasons, however, this is not the case. The largest reason is physical: the Chattahoochee River divides Cobb and Fulton counties and as a result of environmental conservation efforts for the region's primary water source, there are only two bridges over the twelve mile stretch of river between I-75 and GA-400. Both bridges are notoriously congested. A \$0.50 toll is also present on GA-400, between I-285 and its termination at I-85, which may influence some regular commuters to choose alternate parallel routes.

Proximity to Observation Site

The minimum straight-line distance between the geographically reduced vehicle registration addresses and the three perimeter observation sites at which the associated vehicles were spotted is presented in Figure 6. As seen in this histogram and the previous commutershed diagrams, vehicles had traveled an average of at least 13.0 crow-fly miles (SD = 9.5 miles) by the time they were recorded by Commute Atlanta researchers. The I-75/85 Connector site (not shown) had mean and standard deviation potential travel distances of 15.3 and 9.9 miles respectively. An additional spatial analysis of the straight-line distance between highway centerlines and vehicle registration addresses indicated that typical commuters had traveled at least 4.2 crow-fly miles (SD = 4.3 miles) from their homes to the highways.

These mean distances are applicable only to those commuters having vehicles registered within 60 miles of an observation site. Long-distance “supercommuters” would skew the mean upwards while people with vehicles registered further away from where they are actually commuting from would skew it downwards. Further research utilizing actual road networks is needed to refine these estimates which may be useful in assessing proper pricing structures (time vs. money tradeoffs) should highway toll lanes be implemented in the Metropolitan Atlanta area.

Figure 6: Crow-Fly Distance from Vehicle Registration Address to Observation Site



Assuming that the majority of vehicles observed at rush hour were traveling between home and work, the great similarity between the distance distributions shown in Figure 6 indicates that there may be some initial time or distance threshold that people are willing to tolerate when choosing their work and home locations. This premise was examined by Levinson and Wu (6) who concluded that commuting times were actually unstable and depended upon geography of a place. However, given Atlanta’s physical and population growth, it is plausible that people did settle somewhere within a certain time threshold (corresponding to perceived travel times on preferred routes), which was then challenged by the inability of transportation infrastructure to keep up with growth over the years, thus resulting in longer-than-

anticipated commutes. Regardless of actual time or distance traveled, the intent (a personal commute budget) may be the same. These analyses will be refined in 2008 using GIS network modeling routines.

Demographic Analysis

Using Census 2000 data, a blockgroup level analysis was performed on various demographic characteristics to determine the ways, if any, that freeway commuters differed from the general population at the MCB regional and county levels. The Atlanta metropolitan area has continued to experience unprecedented multi-faceted growth since 2000, so the census data are already somewhat outdated. The census tends to undercount items such as household and overall population and the number of workers residing in each blockgroup. Travel time to work has increased (7) and post-Katrina gas prices have likely impacted people's means of transportation to work and perhaps the level of carpooling since 2000. Geographically, new blockgroups have since been created from existing ones in an attempt to maintain a relatively consistent blockgroup population of approximately 1500 households. All of these factors should be taken into account when evaluating the analysis. Regardless of the potential for bias, however, the 2000 Census provides the most recent, fine-grained data available with a large enough sample size to provide relatively confident predictions.

The 20,000+ license tag observations were geocoded to census blockgroups to produce an observation frequency variable for each blockgroup. The observation frequency was used to weight the commuter blockgroup data to provide a clearer picture of the type of households making freeway-based morning peak hour trips.

For each variable analyzed, a χ^2 (chi-square test) was run to determine whether the expected "base" distribution and the observed "commuter" distributions were significantly different. Histograms were used to generate normalized frequencies based upon the observed sample size for either the overall dataset or individual counties. The sample sizes ranged from about 4,800 to 6,400 at the county level (see previous Figure 3) for the top three counties, and equaled 20,137 observations for the entire multi-county dataset. Chi-square goodness-of-fit tests were then performed on the [sample size] normalized frequency distributions. Grouped means and medians were also calculated for variables, when applicable.

The census data provide insight into household characteristics by blockgroup in 2000. That is, the income distributions by blockgroup are related directly to household-level census data. However, license plate data collected in the field are linked back only to census blockgroup and not to the individual household. The field data can only be inferred to the household level based on blockgroup observation frequencies and the existing blockgroup variable distributions and are not based upon direct household knowledge. In comparative analyses presented hereafter, the census distributions will be termed "expected"

demographic data, whereas the data from license plates allocated to their census blockgroup data will be termed “allocated” data.

Characteristic Block Group Income Distribution

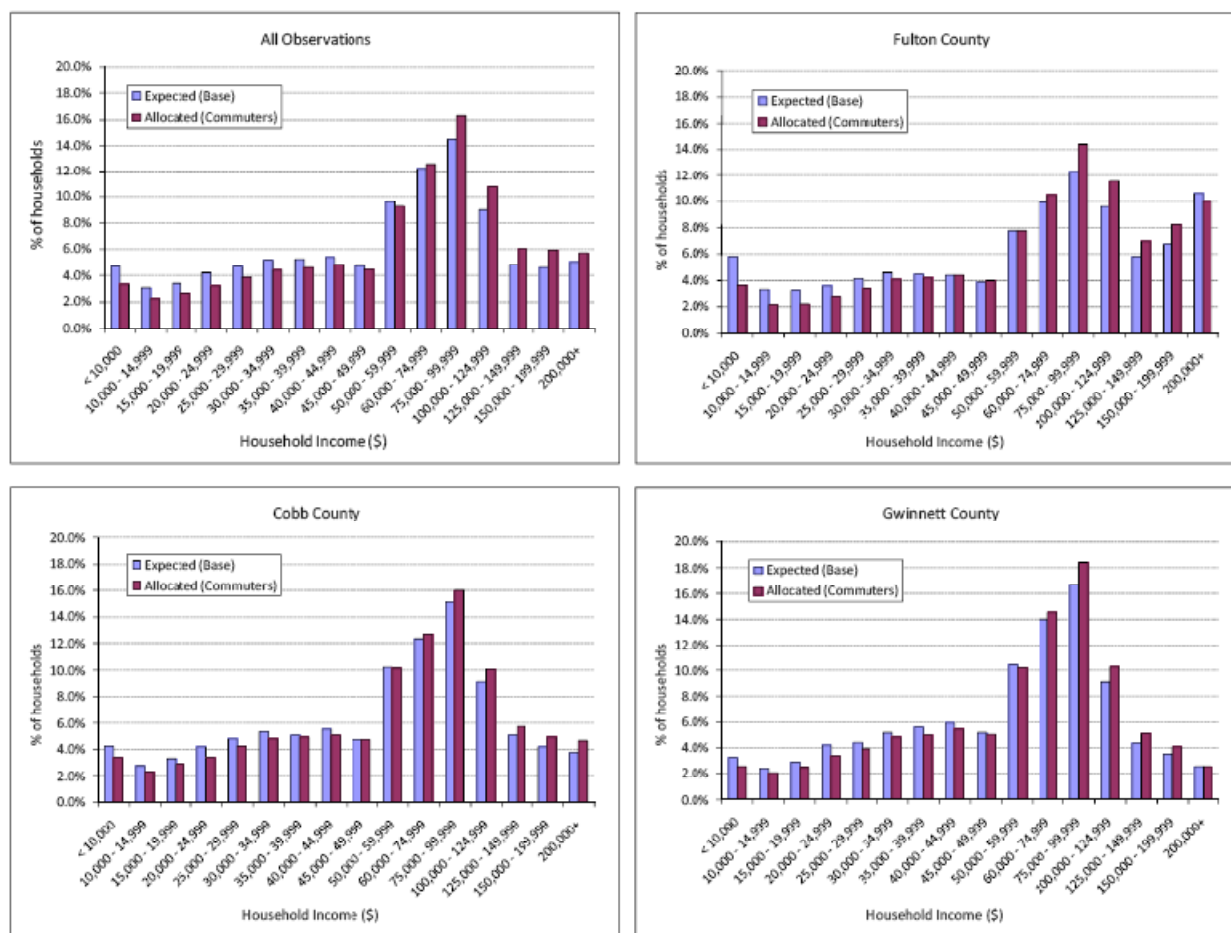
Pronounced differences can be seen in the demographic make-up of rush-hour highway commuters versus their counties of origin. Table 3 depicts the household income distribution of the entire dataset and selected counties. With the exception of Paulding County (not shown) which had a very low sample size, all counties displayed the same tendency towards showing that rush hour commuters were over-represented in households making more than \$60,000 per year. Based on a grouped median calculation, highway commuters had a household income almost 15% greater than other MCB residents. However, the discrepancy between the allocated and expected values is likely a conservative estimate, as highway commuters were assumed to have the same income distributions as their underlying blockgroups (albeit weighted by overall observation frequency). Figure 7 shows a percentile histogram of the entire allocated (commuter) and expected (base) dataset. For brevity, the results of the remaining multi-bin analyses are shown in graphical form only.

Table 3: Expected Versus Allocated Income Distribution by Commutershed

Census 2000 Data		Cobb (n = 6389)			Fulton (n = 5343)			Gwinnett (n = 4799)			All observations (n = 20137)		
Income Bin	Midpoint	Expected	Allocated	% diff	Expected	Allocated	% diff	Expected	Allocated	% diff	Expected	Allocated	% diff
< 10,000	5000	274	218	-20.4%	310	193	-37.7%	157	122	-22.3%	946	664	-29.8%
10,000 - 14,999	12500	177	146	-17.5%	176	115	-34.7%	118	101	-14.4%	608	453	-25.5%
15,000 - 19,999	17500	211	185	-12.3%	173	119	-31.2%	140	121	-13.6%	683	526	-23.0%
20,000 - 24,999	22500	268	216	-19.4%	191	148	-22.5%	201	161	-19.9%	840	640	-23.8%
25,000 - 29,999	27500	306	272	-11.1%	220	179	-18.6%	214	188	-12.1%	936	774	-17.3%
30,000 - 34,999	32500	342	305	-10.8%	245	215	-12.2%	250	231	-7.2%	1038	893	-14.0%
35,000 - 39,999	37500	324	316	-2.5%	237	224	-5.5%	268	239	-10.8%	1046	926	-11.5%
40,000 - 44,999	42500	355	325	-8.5%	235	235	0.0%	287	261	-9.1%	1081	973	-10.0%
45,000 - 49,999	47500	304	301	-1.0%	206	212	2.9%	249	241	-3.2%	956	903	-5.5%
50,000 - 59,999	55000	654	648	-0.9%	416	415	-0.2%	502	491	-2.2%	1929	1861	-3.5%
60,000 - 74,999	67500	791	811	2.5%	550	560	1.7%	671	698	4.0%	2459	2525	2.7%
75,000 - 99,999	87500	967	1023	5.8%	658	767	16.6%	802	884	10.2%	2913	3273	12.4%
100,000 - 124,999	112500	582	643	10.5%	510	617	21.0%	438	494	12.8%	1802	2164	20.1%
125,000 - 149,999	137500	322	367	14.0%	311	372	19.6%	209	247	18.2%	968	1219	25.9%
150,000 - 199,999	175000	270	316	17.0%	359	439	22.3%	169	196	16.0%	925	1192	28.9%
200,000+	300000*	242	299	23.6%	565	533	-5.7%	123	121	-0.8%	1006	1153	14.6%
Mean	-	74,833	80,754	+ 7.91%	94,069	99,800	+ 6.09%	71,866	75,814	+ 5.49%	77,459	85,739	+ 10.69%
Median	-	59,686	64,870	+ 8.69%	67,420	76,832	+ 13.96%	60,283	65,197	+ 8.15%	60,033	68,655	+ 14.36%
P(Chi-Squared)		0.00000			0.00000			0.00000			0.00000		

* The median HH income for the \$200,000+ bin was estimated to be \$300,000, due to lack of additional census data. This estimate affects the grouped mean value only.

Figure7: Expected Versus Allocated Household Income Distribution, All Observations

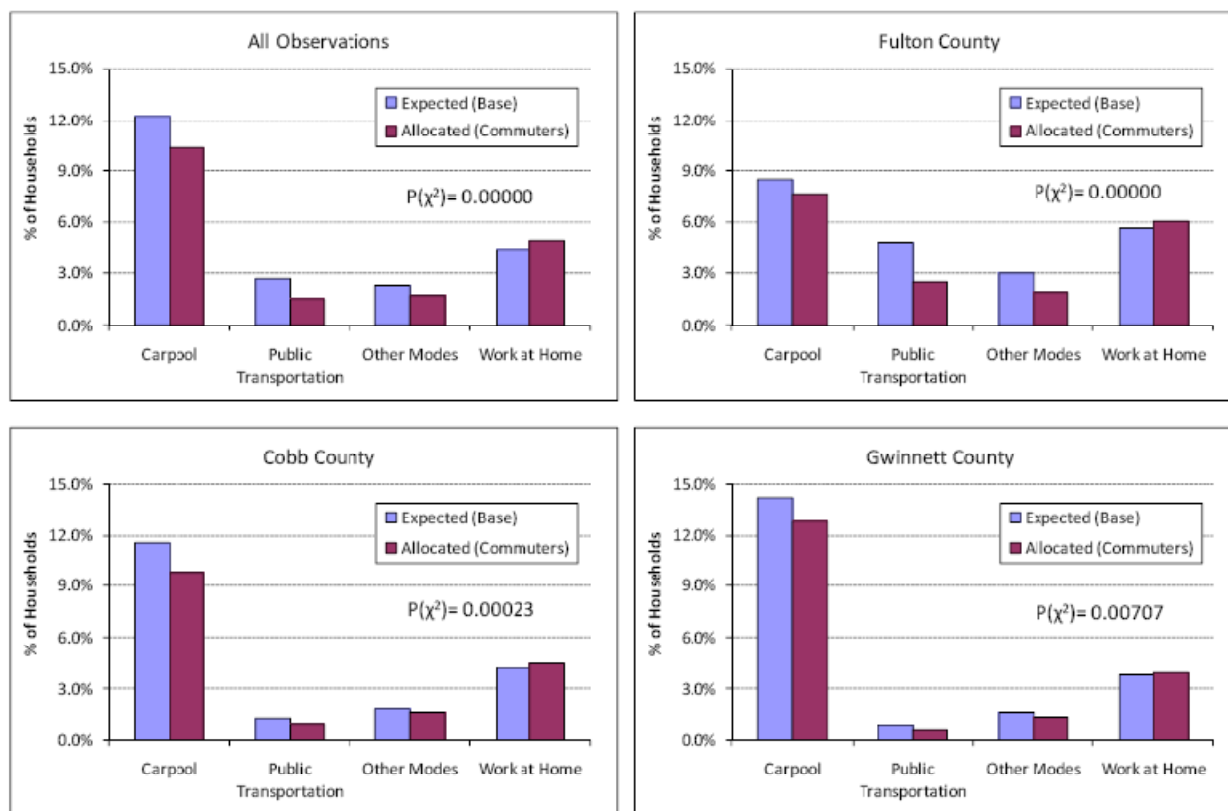


Clockwise from top left: All counties (n = 20,137), Fulton County (n = 5,343), Gwinnett County (n = 4,799), Cobb County (n = 6,389)

Means of Transportation to Work

Figure 8 depicts the census-derived means of transportation mode to work for the three counties that most commuters originated from and for the entire observed sample. The “drive alone” share was over 80% of all home-work trips in every instance and thus only the remaining modes are shown. For rush-hour commuters, increased driving alone and working at home came at the expense of all other transportation modes, including public transportation, walking, or biking. This result persisted across counties and commutersheds, even in areas with greater public transportation accessibility.

Figure 8: Use of Non-SOV Transportation Modes

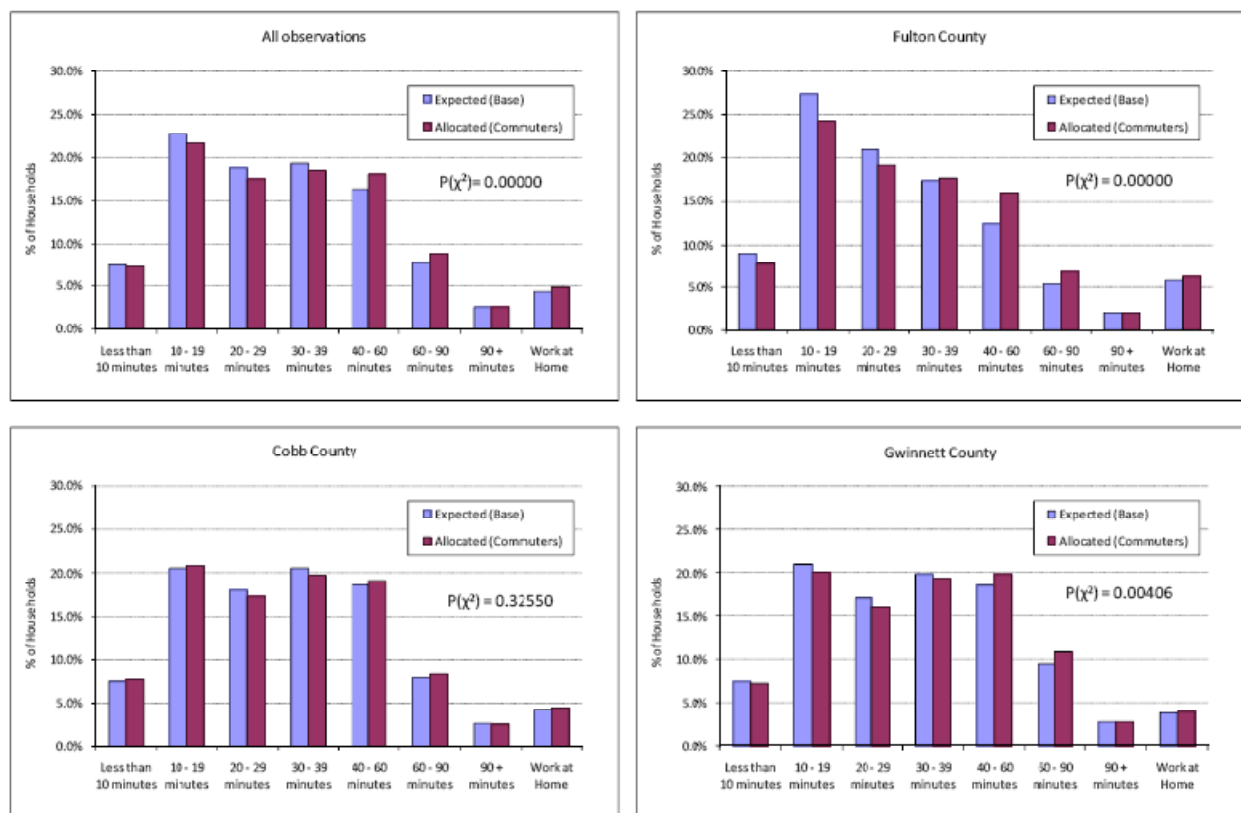


Clockwise from top left: All counties (n = 20,137), Fulton County (n = 5,343), Gwinnett County (n = 4,799), Cobb County (n = 6,389)

Travel Time to Work

To address potential response bias to census questions regarding travel time, travel times were re-binned (aggregated upward) in the three primary counties and in the overall sample. The re-binned distributions are illustrated in Figure 9. While the charts show that rush hour highway commuters tend to have longer travel times than their neighbors, a χ^2 (chi-square test) was significant for all samples shown except Cobb County. This result may come from the geographic distribution of activity centers, where easily accessible regional activity centers are lacking on I-75 inside of I-285, but are plentiful outside of it, thus potentially skewing the commute distance to either very short or very long trips. Given this potential the histograms show that expected time savings from using high-capacity and high speed limit routes do not apparently hold true, probably due to mitigating congestion.

Figure 9: Travel Time to Work



Clockwise from top left: All counties (n = 20,137), Fulton County (n = 5,343), Gwinnett County (n = 4,799), Cobb County (n = 6,389)

Conclusions

In addition to providing a set of “focus” blockgroups for use in targeting potential Commute Atlanta congestion-pricing study participants, the license plate data provided direct insight on rush hour highway commuters at an unprecedented scale. Using a GIS environment, typical highway commutersheds and associated census data observations were generated. Though their final destinations were unknown, it was observed that commuters had traveled on average a minimum of 13 miles before reaching the locations at which their license plates were recorded. A distance analysis indicated that the majority of people’s journeys to that point were most likely taken via a major highway as they originated, on average, at least 4.2 miles away from the centerline of the facility on which they were observed.

In general, based upon census data analysis and observation frequency, the observed morning rush hour highway commuters were less likely to carpool, take public transportation, or utilize other non-SOV modes than the average resident of the same blockgroup. They were more likely to work at home and had incomes that were on average 15% higher. Perhaps because of their vehicular usage during peak

periods, or because they potentially traveled a greater distance, the blockgroups that commuters originated from tended to display longer commute times.

The longer travel times and high incomes observed in the study indicate that people may be willing to travel further for more prosperous job opportunities (8). However, it is also possible that multi-income households yield compromises in household location decisions, resulting in longer commutes for one or both workers. Planning efforts may benefit significantly if future detailed surveys could be conducted at the household level to provide insights into the reasons for household location choice correlated directly with commute travel activity.

When a highway at rush hour is the route of choice, environmental equity considerations can arise due to the effects of congestion on air quality in the immediate surrounding areas. These externalities can be at least partially mitigated through the use of toll or other managed lanes during congested periods, which would encourage faster travel speeds and thus decrease the vehicle-based emissions of most primary pollutants. Since rush-hour commuters have a greater household income level than the general populace, imposing a fee for usage of particular high-capacity roads may amount to progressive taxation, potentially dampening some concerns about the effects of managed lanes on vertical (income) equity. The results from such corridor commuter studies could be coupled with panel studies to identify potential equity concerns and develop strategies to mitigate such concerns.

When considering implementing managed lanes on a highway facility, it is thus important for planners and decision-makers to understand that the socioeconomic and demographic data for the county in which a project would be implemented is likely to be different from that of the actual commutershed, and that even the overall commutershed is likely to be different than the variable (income, mode split, etc) distributions seen in the census blocks where vehicles are registered. That is, the users of a freeway during the morning peak period are generally higher income than the potential commutershed which, in turn, is higher income than the county containing the facility. The combination of higher incomes and longer commute times may lead to an increased willingness-to-pay for managed lane facilities with guaranteed travel time savings.

Future Work

The primary weakness of this study is that it analyzes data only from northside commuters, who are distinctively different from those on the south, west, and east sides of the metro Atlanta area. Additionally, it is currently impossible to know whether people actually reside at the locations where their vehicles are registered, though this assumption is required as a condition of analysis. A follow-up telephone or mail-out mail-back survey could address this issue. Although census data on vehicle ownership are lacking at the blockgroup level, it would be possible to obtain this information from the Georgia vehicle registration database to determine additional commuter characteristics for the study dataset. If previous research is correct and the education level of commuters may also have relevant impact on their potential response to congestion pricing activities (9), then this variable may also need to be included in future studies.

For each highway, the magnitude and angle of the commutershed could be calculated analytically and perhaps be applied to other highways around the country to determine their “regional attractiveness”, similar to those studies undertaken for malls or other large activity centers. Supplemental analysis will refine the travel distances and travel times undertaken by the observed vehicles so that network mile and time estimates can be examined rather than crow-fly distance measures. Network connectivity assessments can also be conducted. For potential congestion activities, it would be useful to perform network analyses and determine the actual distance that people potentially drive on highways or other routes where tolls could be implemented. Fleet characteristic data corresponding to the vehicles observed can be used to calibrate regional air quality and emissions models; in fact, work has begun on this already for the Atlanta region.

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Congestion Pricing Response

Section IV: Focus Groups



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Congestion Pricing Response

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About Georgia Department of Transportation

The Georgia Department of Transportation (GDOT) plans, constructs, maintains and improves the state's roads and bridges; provides planning and financial support for other modes of transportation; provides airport and air safety planning; and provides air travel to state departments. For more information, visit www.dot.state.ga.us.

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Introduction

This report provides the results of nineteen focus groups that were conducted as part of the Congestion Pricing Response project. The first section provides an overview of the focus groups' characteristics, a description of the facilitation process, and a summary of the focus groups' opinions on potential congestion pricing programs in the Atlanta area. The second section provides a narrative summary of all of the focus group responses to the discussion questions and provides results and analysis of the quantitative questions that were posed to the groups. Finally, the Appendix provides the pre-and post-focus group surveys that were completed by the participants (Appendix G) and detailed responses from each focus group with detailed descriptive tables of each participant [names withheld] (Appendix H).

Focus Group Summary and Methodology

Focus Group Characteristics

Nineteen focus groups were assembled to identify and measure the attitudes, perceptions, preferences and general response to a variety of congestion pricing programs and to specific examples of pricing projects in the Atlanta area. This included an examination of different pricing technologies, toll collection methods, financing and pricing preferences (willingness to pay), and expectations and benefits associated with pricing programs. In addition, the focus group participants were evaluated as to their current familiarity with congestion-pricing technologies and their feelings thereon. Special consideration was given to potential public objections to congestion pricing—for example, if users were to consider congestion pricing “double taxation” or regard toll lanes as “Lexus lanes” enjoyed only by the wealthy.

Group composition reflected the wide array of potential users and non-users in the region, stratified by socio-economic profiles, trip-making characteristics, geography, awareness of pricing alternatives, and priorities for the congestion pricing program in the region (Table 1, 2 and Figure 1). Information was solicited from focus group members on the presentation and implementation of a congestion-pricing program for the region to include the identification of any concerns or apprehension they might have had such a program.

The groups consisted of 8-12 participants and one facilitator for a 90-minute discussion and were conducted at a professional facility. Representatives of the Georgia Tech team observed the groups from behind a one-way mirror and utilized audio and visual recording. The questions for the focus groups were based on sets identified during the literature review and focused on public awareness of pricing options, preferences for pricing within the region, and constraints on individuals' travel behavior.

Table 1: Characteristics of Focus Group Participants by Commute Corridor

Commute Corridor	Other Characteristics	# of Participants
Northside I-85	High Income (\$100k +)	11
Northside I-85	Mid Income (\$50k - \$99k)	12
Northside I-85	Low Income (Under \$49k)	10
Northside I-85	Regular Carpoolers	8
Northside I-75	General Users	8
Northside I-75	General Users	11
GA 400	Fast Pass Users	8
GA 400	Fast Pass Users	8
GA 400	Cash Toll	11
Varied	GRTA Express Bus Riders	12
Eastside I-20	General Users	11
Eastside I-20	General Users	9
Southside I-75	Mid Income (\$50k - \$99k)	7
Southside I-75	Low Income (Under \$49k)	11
Southside I-75	High Income (\$100k +)	8
Northside I-85	Gwinnett Express Bus Riders	12
Northside I-85	Low Income (Under \$49k)	9
Northside I-85	High Income (\$100k +)	9
Northside I-85	Mid Income (\$50k - \$99k)	8
	Total Attendance	183

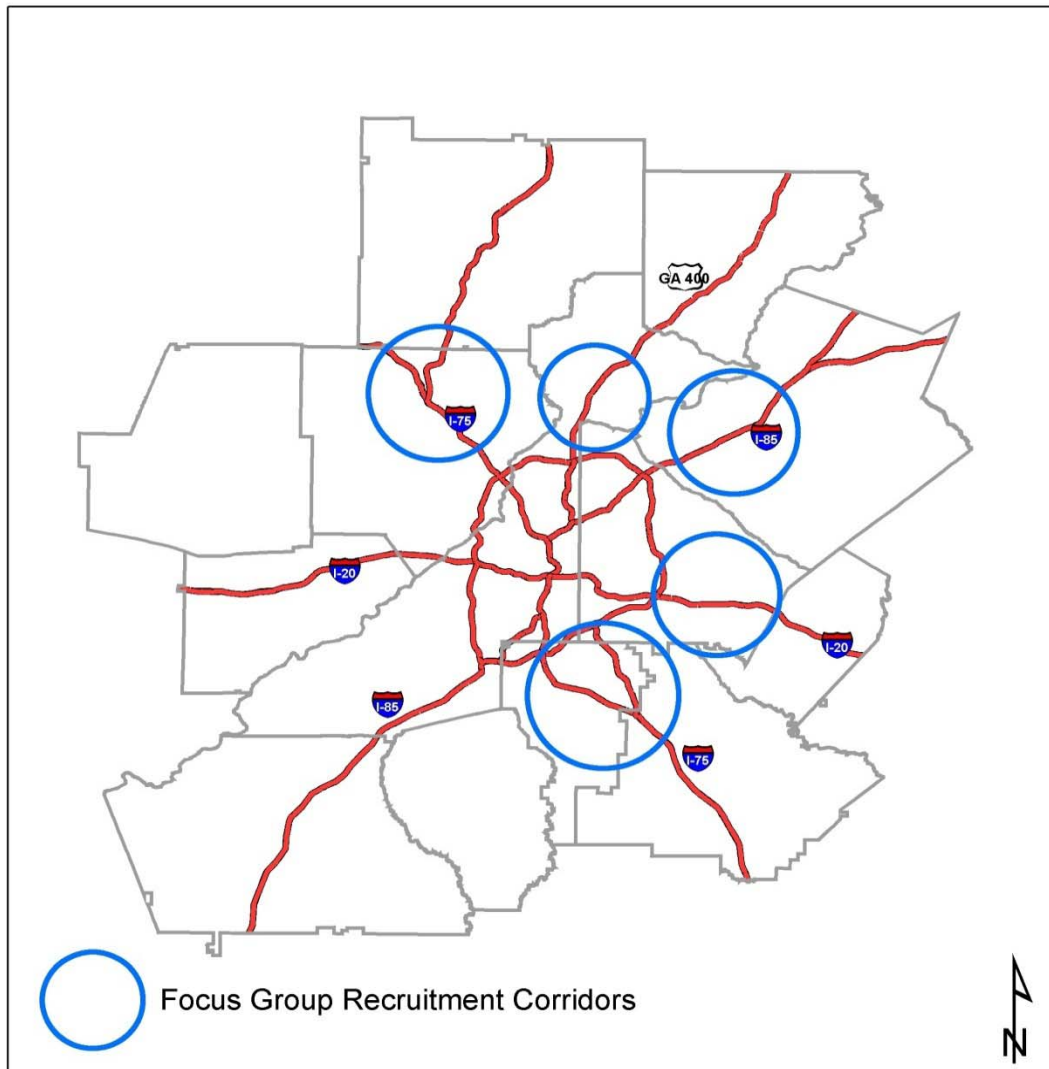
Table 2: Focus Group Socio-Demographic Characteristics

		Actual Number	Percent of Total
Sex	Male	95	50.8%
	Female	92	49.2%
Age	18-34	44	23.5%
	35-44	53	28.3%
	45-54	60	32.1%
	55+	30	16.0%
# of People in HH*	1-2	76	43.7%
	3+	98	56.3%
# of Children*	0	89	51.1%
	1-2	70	40.2%
	3+	15	8.6%
# of Vehicles in HH**	1	32	21.1%
	2	56	36.8%
	3+	64	42.1%
Ethnicity	Cauc	127	66.1%
	AA	53	27.6%
	Asian	7	3.6%
	Hisp	3	1.6%
	Native Amer.	1	0.5%
	Mixed	1	0.5%
Income*	Under 49	43	23.9%
	50-99	68	37.8%
	100+	69	38.3%
Education*	GED	2	1.1%
	HSG	19	10.6%
	SC	51	28.5%
	CG	73	40.8%
	PG	34	19.0%
Marital*	Single	43	23.9%
	Married	106	58.9%
	Divorced	24	13.3%
	Widowed	7	3.9%

*Question not asked in focus group #16

**Question not asked in focus groups #16-19

Figure 1: Focus Group Recruitment Corridors



The Facilitation Process

Nineteen focus groups were held at Atlanta Focus between January 7 and September 8, 2008, and lasted for 1.5 – 2 hours, depending on the size of the group. Each group was presented with the same introductory material, and performed the same introductory exercise.

First, the facilitator introduced herself as a consultant to the Georgia Institute of Technology (GA Tech).

Second, the facilitator discussed the purpose of the discussion by noting that the Georgia Department of Transportation (GDOT) had hired GA Tech to evaluate four possible strategies for managing congestion on highways in the Atlanta region. As part of this work, GA Tech would be conducting focus groups to

help GDOT understand the public's reaction to these four possible strategies. The facilitator emphasized that no choices had yet been made about how to approach the congestion issue, and that the focus groups would help GDOT decide what will best serve local needs.

Third, the facilitator stated that the main focus of the discussion was on highway congestion during the morning and afternoon “peak” driving periods, generally from 7:00 a.m. to 9:30 a.m. and 4:00 p.m. to 6:30 p.m. She emphasized GA Tech’s interest in hearing about experiences on the freeways during commute times, as well as during other types of trips like shopping or travel to and from recreation activities.

Fourth, the facilitator emphasized the confidentiality of each discussion, stressing that GA Tech researchers may not disclose any information that can be linked back to individual participants or their households.

Fifth, the facilitator provided housekeeping information, went over the ground-rules for the discussion, and acknowledged that each participant would receive \$85 for their participation.

Sixth, the facilitator read the Research Consent Form out loud, answered any questions, and directed participants to sign the form.

Finally, participants introduced themselves by describing where they lived and worked, as well as how they got to work and how long a commute they had.

The discussions were divided into Track A and Track B. Both Tracks started with Managed Lane questions (HOV, HOT, Variably Priced HOT and Express Lanes) and both ended with a “Big Take-Away” questions focused on if and how participants might change their commute behavior if GDOT introduced managed lanes to the region. In addition, both Tracks included questions on how to spend potential excess revenue. Track A, however, included a section on Revenue Collection Technology, while Track B had a section on Enforcement Strategies and Technology.

In addition, participants filled out pre- and post-discussion written surveys (see Appendix G).

Summary: Public Perceptions of Congestion Pricing in Metropolitan Atlanta

Focus group participants were given information on three types of managed lanes (high occupancy toll [HOT], variable priced high occupancy toll [VHOT], and express lanes) and were presented with several questions, including what they liked or did not like about the types of managed lanes and under which conditions they would use the managed lanes. In all of these instances, respondents were asked to assume that there would be a guaranteed speed of 45–55 mph on the facility and that single-occupancy vehicles (SOVs) would be allowed to pay to use the lanes (for both of the HOT options). There were also questions about the general nature of managed lanes and how they would operate, how they would be created, and how toll proceeds should be allocated.

Preliminary analysis of the focus groups responses suggests that public attitudes towards congestion pricing programs in Metropolitan Atlanta are similar to those seen in other areas of the United States. Respondents were generally open to listening to solutions that may reduce congestion. There was a general distrust of the ability of governmental agencies to provide guaranteed speeds or to properly manage the facilities or the proceeds from the tolls. There were also concerns about lanes being “taken away” from general use and congestion pricing amounting to “double-dipping” by the government, since fuel taxes are already being used for road-building. This concern was raised with respect to current HOV users now having to pay if an HOV lane was converted to a toll lane, and with respect to general lane users losing a lane if general purpose lanes are converted to a tolled lane and they cannot afford it. Additionally, concerns about the fairness of congestion pricing programs were articulated.

When asked what attributes they liked about HOT lanes, respondents commented on guaranteed speeds, the ability of SOV to pay to use the facility, and the overall reduction of congestion on both the HOT and general purpose (GP) lanes. Dislikes of the HOT lane concept included a lack of trust that the guaranteed speed will be provided, concerns about accidents in the HOT lane, worries about the toll being in effect double taxation, and concerns about construction costs.

When asked what attributes they liked about VHOT lanes, respondents liked the market-driven nature of the concept, the possibilities for higher congestion relief, the increased flexibility, and the possibility for discounted toll prices at low congestion or off-peak hours. The dislikes of the VHOT concept included concerns about the complexity of implementing and utilizing a variable pricing scheme, difficulties that variation in tolls would have on [personal] travel expense budgeting, the potential for the tolls to be regressive (lower income drivers may not have the flexibility to avoid high toll times), and a distrust in the government’s ability to accurately verify vehicle speeds.

With regards to express lanes, respondents stated that the lanes would be beneficial for drivers with long commutes, increase safety due to a minimization of weaving into and out of the lane, and provide a good alternative for non-commuting vehicles driving from one side of town to the other without the need to stop. The dislikes of express lanes include concerns about the effect of breakdowns or accidents in the lane, the lack of convenience due to the limited number of access and egress point, and the potential confusion during the implementation phase and for out-of-town drivers.

When asked about the possibility of converting existing HOV lanes to managed lanes (any of the three options) there was a concern, especially from current HOV users, that it would constitute taking away something that is currently free. In general, however, there were roughly equal responses for HOV conversion and new construction.

Participants were instructed to assume that they were guaranteed a 45-55 mph average speed and the general lanes were moving 25-30 mph on average. Under those circumstances, a strong majority of participants expressed a willingness to use the proposed lanes, with HOT lanes being the most likely to be used. Additionally, of those that stated that they would not use the facility regularly, many stated that they would use it on specific occasions such as; times with heavier than normal congestion, when the toll is low (particularly for the VHOT facility), running late to work, going to the airport, going out of town, and going downtown for a special event like a sporting event or concert.

Participants who reported regularly using current managed-lane or corridor facilities (such as the existing HOV lanes or the Georgia-400 CruiseCard transponder program) were more likely to express a willingness to use an HOV facility than were all participants as a whole. These results are consistent with the findings in the literature review chapter of this project suggesting that familiarity with congestion pricing or managed lanes increases the likelihood that the user will support congestion pricing.

There were several questions posed to the focus groups to gauge their thoughts on how fair and equitable they thought the concept of congestion priced facilities. Many of the groups thought that managed lanes were generally fair, stating that if managed lanes can reduce overall congestion, then everyone, including drivers in the general-purpose lanes, would benefit. The fact that use of the lanes would not be mandatory was also cited as evidence of the fairness of the managed-lanes concept.

However, some specific concerns regarding equity and fairness were raised. The tolls were seen by some as amounting to “double-dipping” by the government, since taxes have already paid for the roads. Managed lanes were seen to be somewhat unfair to those who would not have the ability or flexibility to adjust commute times or form car pools, or to those who are already using the existing HOV lanes at no

charge. Furthermore, the tolls would be regressive to those with low incomes or those on fixed incomes. There were also some concerns that managed lanes (or lack thereof) may be unfair to the areas that do not get the facilities first.

The results from these focus groups contain much valuable information that will lead to a more thorough understanding of public attitudes towards and willingness to accept different congestion pricing facilities. The focus groups were segmented (see Table 1, above) to allow for more in-depth analysis taking into account how socio-demographic and other factors such as current commute experience and mode affect people's attitudes towards congestion pricing.

Focus Group Summary Results: Discussion Questions

The following questions and summarized answers are organized by section, with key themes identified at the beginning of each question. Responses are ranked by the number of focus groups in which they appeared, with the most frequent listed first.

HOV Lane Questions

3. For those who have used an HOV lane, what have been your experiences, both positive and negative?

- Positive:
 - The most consistent responses to this question had to do with reduced congestion and time saved on the lane, the fact that the lane rewards the good behavior of commuting, and that it is good for the environment.
 - The lane saves time—less congested (13)
 - Can cut commute by as much as 30 min.
 - Better in the a.m.
 - Never on 75/85 South
 - Rewards good behavior—i.e., carpooling (2)
 - Better for the environment (2)
 - HOV on 75 goes faster than on 85
 - Works best at certain times, esp. between 10:30—lunch and 1:30—3:30
 - Helpful when I have my kids in the car
 - Helps me get around downtown construction
 - Great when there's a back-up on the GP lane (2)
 - Saves gas
 - There is a lot of traffic in off-peak periods, good that it's HOV 24/7

- Enforcement is strong (3)
- Like the left-hand exits—easier than right lane exits
- Negative:
 - The most consistent responses to this questions had to do with the lane's high level of congestion, the challenges of entering and exiting the lane, drivers using HOV as a passing lane, and drivers going too slowly.
 - The lane doesn't save time—just as congested (12)
 - Esp. on 85N in p.m. rush hour
 - No advantage during rush hour
 - Hotspots: MARTA @ Mansell or Windward, North Springs
 - Entry/exit difficult—(12)
 - Especially crossing over GP lanes
 - Hard to wait for dashed lines, don't seem to link to exits
 - Makes it difficult to plan ahead
 - Used as a passing lane (8)
 - Cars drive too slowly (10)
 - Older drivers
 - SOVs use the lane (6)
 - Not enough lanes throughout region (5)
 - Need more HOV on 85 further north
 - Need more outside 285 (85 pretty good)
 - Not available for my commute
 - Often empty—underutilized (4)
 - Shouldn't be used as HOV 24/7
 - Used as a speeding lane (4)
 - Needs more enforcement (esp. for crossing over solid line) (6)
 - Except for airport—strong enforcement!
 - More penalties
 - Children shouldn't count towards a carpool (3)
 - Not legal drivers, not taking car off road
 - Pregnant drivers try to use lane
 - Dashed-line entry/exit can create bottlenecks (2)
 - Cuts down on emergency lane (3)
 - When it's available, you don't need it (2)
 - 75/85 merger is dangerous (2)
 - Some exits only available from HOV lanes, doesn't work for SOVs (2)
 - Accidents cause additional back-up

- Big trucks and vans often weave or stop
- People cheat the system
- Buses drive slowly on the lane
- Entrances and exits poorly marked (near IKEA and where 400 meets 85 S.)
- If you push more people to carpool, it will become congested
- Using cops for enforcement causes congestion (2)
- Out-of-state drivers don't know how to use it—need better signage
- Feels unsafe- driving so close to the wall, having no shoulder

4. If you have not used an HOV lane, what are the main reasons that you do not currently use them?

- The most consistent responses to this question include driving alone, HOV lane not available for my commute, don't perceive I will get any extra speed, and am scared to use it or don't like to use it.
- Mainly drive alone (14)
- Work schedule stops me from committing to car-pools (2)
- Not available on my commute (7)
- 20 outside of 285
- 400/285
- Don't perceive I'll get extra speed (5)
- Scared to use it/Don't like to use it (6)
- Rules are confusing
- Exits are unpredictable
- Hard to cross over GP lanes to enter/exit lane
- Carpools are too hard to organize (3)
- Have to drive places during and after work, so I need my car
- Conditioned to sit in traffic
- Not in a rush

HOT Lane Questions

6. What do you think you would like or dislike about HOT Lanes?

- Like:
 - The top positive responses to this question include the guaranteed speed of 45–55 mph, the SOV pay-in option, and the reduction in overall congestion on both the HOT and GP lanes.
 - Like the guaranteed speed of 45–55 mph (11)

- Would make commute more dependable
- Would make commute time shorter
- More likely to be on time to work
- Lead to less congestion
- Like the refund offer if speed not met
- Could help in emergencies/special circumstances
- SOV pay-in (6)
- Toll would be lower than a ticket for illegally driving on HOV
- I'd use it
- Works well for folks who have barriers to participating in carpools
- Would reduce overall congestion (HOT and GP lanes) (3)
- Saving time would increase my quality of life (3)
- Good to have more options (4)
- Would raise more revenue for GDOT, help with maintenance and projects (3)
- For folks who are paid by delivery, more speed means more pay
- Less pollution caused by sitting in traffic
- Push people to plan their trips more
- The toll would weed out slow drivers
- The technology is already in place (Cruiser Card on 400/GA Navigator)—just have to adapt it
- Rewards larger carpools (2)
- Dislikes:
 - The top negative responses to this question include a lack of trust in the guaranteed speed, a concern about the impact of accidents on HOT lanes, an assertion that the toll constitutes double-dipping (see below), and a concern about the cost of construction.
 - Don't trust we will actually get guaranteed speed (4)
 - 75/85 already so impacted by tourists, travelers, commuters
 - Accidents (4):
 - If there is accident on GP, would push folks to HOT, causing congestion
 - Confusing to use, could cause accidents
 - Slow drivers on HOT could cause accidents
 - Constitutes a double payment, because we are already paying for the roads through our fuel tax (3)
 - It will cost a lot to construct (3)
 - Especially technology
 - Tolls will make driving too expensive (3)

- Why should I pay a toll to drive on the road? (3)
- Just like an HOV lane—now free, why should I pay?
- GA 400 toll—was supposed to go away once construction was done and stayed—don't trust GDOT (2)
- People will game the system and use it for free (4)
- Only people who could pay would benefit (4)
- Folks just won't carpool (2):
- Construction dollars will be wasted
- Traffic not bad enough to force people
- Guaranteed speed too low to make it worth the toll (2)
- Too complex to enforce—what if technology fails? (2)
- Technology breach, incorrect toll charged
- What is our recourse?
- It will be hard to get on/off through GP lanes (2)
- Will only work if drivers go the minimum speed (45-55), many in Atlanta don't on HOV lanes now
- Don't trust GDOT will be able to track speed so they can deliver on the money-back guarantee
- Don't trust toll dollars will be used on toll road
- Don't believe it will reduce congestion any more than HOV
- Once toll is charged, will just go up and up
- Privacy issue: don't want them to use the info about my travel behavior in other contexts (i.e., marital discord)
- Construction of the lane would cause congestion
- GDOT does bad planning, and project implementation is inefficient. This would be the same
- Managed lanes just dealing with the symptom. The more the region grows, the more congestion we'll have, the more toll lanes we'll need
- Enforcement would be difficult—drivers could hop on and off without paying
- General Comments/Questions
 - If GDOT converts (“takes away”) an existing GP lane, it will push drivers to the HOT
 - Needed outside the Perimeter
 - Don't allow large trucks on HOT
 - If trucks go on HOT lanes, would reduce truck-related traffic on GP lane
 - How will location and toll be decided?
 - More likely to use it if with electronic tolling

- Concerned about what GDOT will do with the money raised by tolls—transit? Stolen by administration?
- Could make traffic worse if not accepted and used
- Cruise Card lane on 400 works—very little traffic
- How will GDOT be able to accurately track speed in order to implement the money-back guarantee?

11/17/8. If you would not use the HOT Lane on a regular basis, are there any special times when you might pay to use it?

The top answers to this question include when the freeway is particularly congested, if I'm running late to work/other, going to the airport, or going to a time-specific commitment (wedding, Braves, etc.)

- If freeway is particularly congested (10)
 - Accident
 - Road congestion
 - Bad weather
- If I'm running late (to work, other) (10)
 - Going to an important meeting
- Going to the airport (8)
- Time-specific commitment (wedding, Braves game, theatre, etc.) (5)
- Emergency (personal/medical) (7)
- Picking up my kids at daycare, school (2)
- Leaving town on a Friday or on a holiday (3)
- If I'm paid by delivery, increased speed would mean more money
- If I'm going longer distances
- If I'm tired of being in the car
- If I missed my bus, and SOVs could pay in
- Going to church

12/9. If HOV-2 and SOVs are allowed to pay to use the HOT lane, should HOV-2 pay less? Why or why not?

Group participants gave a range of reasons for supporting lower tolls or equivalent tolls for HOV-2, including the following:

- Lower toll for HOV-2:
 - Would provide a financial incentive to carpool (13)
 - Reduce the number of cars on the road
 - Caveat: kids shouldn't count towards a carpool, wouldn't take car off the road (5)
 - It will promote cleaner air (4)

- If they pay the same, wouldn't align with goal of reducing congestion (3)
 - Fairer, as HOV lane was free
 - Would compensate for the sacrifices inherent in carpooling
- Same toll level of HOV-2 and SOV:
 - People who can't carpool (job structure, lack of available partners) shouldn't be penalized (4)
 - All the cars are traveling on the same road (3)
 - Fairness issue: some can afford to pay more than others (2)
 - Simplify the process, make it easier to enforce (2)
 - Would provide incentive for SOVs to use the lane
 - Reduce temptation to cheat
 - Enforcement mechanism (video) raises privacy issues
 - HOV-2 would pay less if toll was same because it is split between 2 people
- General comments:
 - Carpooling difficult because of job inflexibility and family demands
 - All carpools, regardless of size should drive for free on the HOT, not fair to those with smaller cars who can't put together larger carpools
 - Until gas prices go down, no one should get special breaks
 - Most carpools aren't taking cars off the road as they are usually families driving together

14/10. Would you participate in a 2-person carpool in order to split the costs of using the lane?

Although this question was primarily answered with a show of hands ("yes"/"no"), in several groups participants also expressed a range of opinions and questions, including the following:

- Participants expressed anxiety about being able to find a carpool partner who lived near them, worked with them and had the same work schedule as them (3)
- Participants expressed concern about needing a car in the middle of the day and being stranded
- Too difficult to coordinate
- Conditions included: no smokers in the carpool, need to know and trust others in carpool (concern for personal safety), matching work schedule.
- Could employer/other centralized agency manage a "vetting" process to vouch for registered carpools? If not (liability issues?), could some central agency at least maintain the identification of carpool participants to track who was driving with whom?

15/11. Would you participate in a 3-person carpool in order to split the costs of using the lane?

Although this question was primarily answered with a show of hands (“yes”/“no”), in several groups participants also expressed a range of opinions and questions, including the following:

- I’d be willing to do it if I could find a reliable partner, my employer provides carpool coordination services, and I save enough in gas that it’s worth the hassle of dealing with a carpool. (2)
- Increasing the number of people in the carpool increased the risk of being late, and makes you more dependent.
- I’d consider it if there were more reliable transit to serve as back-up in case the carpool didn’t work.

17/13. *How would you feel about converting existing HOV lanes, like the ones we currently have in Atlanta, into HOT lanes?*

The most consistent answers to this question included concern about taking away something we are already getting for free with the HOV lane, acceptance conditioned on the SOV pay-in option, a general preference for new lane construction, and a general preference for lane conversion.

- It would be taking away something we already have for free (7)
- Better than taking away a GP lane
- O.K. as long as SOVs can pay-in (3)
- Conversion in general is a bad idea, new construction is better (3)
- Conversion is better than new construction—less congestion (4)
- It’s a tax (2)
- Stop-gap measure—not addressing continued growth will mean we’ll need more managed lanes in the future (2)
- Don’t trust the government to do it right
- If Express Buses couldn’t use HOT, we’d be “losing a lane”
- Don’t want to effect bus fee
- Conversion ok as temporary measure until we can build new lanes
- Either approach o.k. as long as we include emergency lanes—not enough in the region as it is
- Construction (whether it’s conversion or new construction) will increase congestion
- We need managed lanes on *all* the highways, not just some of them

18/14. *How would you feel about converting a regular lane into a HOT lane?*

The most frequently expressed responses to this question included concern about the impact of conversion on the narrower highways outside of I-285, concern about taking away a lane from those who wouldn’t or couldn’t use the HOT lane, general concern about “taking away a lane,” and a preference for upgrading an existing road rather than charging for something that used to be for free.

- Conversion wouldn't work on many of the roads outside of 285—they are too narrow (5)
- It would take a lane away from those who wouldn't/couldn't use HOT (3)
- Better than converting an HOV—upgrading existing road versus taking away something that used to be free (3)
- Taking away a lane (3)
- Would need strong marketing to convince folks to buy it (2)
- Transition difficult: is it HOV or HOT? When do we pay?
- Let's explore using a "switch direction" strategy on the free way, i.e., switching the direction of certain lanes during peak periods to provide more lanes in the more heavily used direction (i.e., Roswell Road, DeKalb Ave.). Allow us to get more lanes without construction
- Good to extend managed lanes outside the Perimeter, where there currently aren't any HOV lanes
- It's a tax
- Good to have an extra option (2)

Variably-Priced HOT Lane Questions

19/15. What do you think you would like or dislike about variable pricing for HOT lanes?

- Likes:
 - The most consistent positive responses to this question included appreciation for the market-driven nature of the lane, the perception of higher levels of congestion relief, appreciation for the increase in flexibility, and the perception of discounted toll prices at low congestion levels.
 - Responds to the market (i.e., level of congestion) (5)
 - Higher likelihood of reducing congestion—higher prices could provide disincentive for use (4)
 - More flexible, gives me more choices (6)
 - Less expensive when congestion is lower—provides a discount (2)
 - Provides incentive to use the lane when the cost is low
 - Gives drivers the choice to make the trade-off: time vs. money
 - Would make commuting less expensive during non-peak periods
 - Could help response times for emergency vehicles (with guaranteed speed)
 - If folks have to pay more attention to the road to figure out the toll, maybe they will talk less on their cell-phones
 - Would free up time and money spent on gas (all managed lanes)
 - We have the technology currently, would make implementation easy
- Dislikes:

- The most consistent negative responses to this question included a concern about the complexity of the strategy and its impact on both implementation and utilization, a concern that the toll variation would make it difficult to budget for travel expenses, a concern about the regressive nature of the toll as well as a distrust of the government's ability to accurately verify speed.
- Too complex and hard to understand and implement (9)
- Don't trust the government to manage this
- How will out-of-towners know how to use it?
- Price variation would make it difficult to budget for travel (7)
- Unfair advantage to higher-income drivers—regressive (3)
- Unpredictable (3)
- Don't trust them to accurately verify speed—would I get my money back? (3)
- Would punish those who *have* to travel during high-congestion periods (.e. workers with less flexible schedules)
- Unpredictability would make it difficult for me to track the amount I'm spending in my "toll account"
- Could slow folks down while they are figuring out the toll
- Could create tensions within carpools based on time of day each participant is driving
- As gas prices continue to rise, I wouldn't be able to afford the toll as well
- Installation expensive—lots of technology to manage variable pricing and money-back guarantee
- Shouldn't have it 24/7—esp. not during non-peak times
- What if a car isn't registered, or is stolen? How will the system deal with charging for the toll?
- Costs of enforcement/administration too high relative to expected benefit
- Hard to make the decision about using the lane at the moment you're entering the highway
- Installation—whether conversion or new construction—would cause congestion
- Conditions for Success/Utilization:
 - Decision would depend on toll level (2)
 - Depends on how people behave in the lane, i.e., truly drive at available speeds
 - Depends on how congested the GP lanes are
 - Trucks are a major cause of congestion, and should only be allowed on during certain times of the day
 - I'd use it if my tolls were deductible as a self-employed person
- Questions:
 - Where would toll money go?

- Could commercial vehicles use the lane?
- How would tolls be set? Will tolls be charged based on # of exits or miles driven, or a single fee for all users?
- Would I be charged more than once if I used several highways with VP HOT lanes during my commute?
- Why aren't we focusing more on increasing transit utilization?
- How much of the length of the highway will they use when determining average speed?

21/17. If you would not use the lane on a regular basis, are there any special times when you might pay to use the lane?

See #11 plus: Would use when the toll is low

Express Lane Questions

18/23. What do you think you would like or dislike about Express Lanes?

- Likes:
 - Faster ride (10)
 - Less passing/weaving would mean less accidents (14)
 - More easily enforceable—fewer drivers could “game the system” (6)
 - Make it safer by reducing the number of people getting on and off the highways
 - Good for people with long commutes (14)
 - Could be used to segregate trucks from the rest of the highway (3)
 - Would work for out of town drivers who want to go through Atlanta and not stop (4)
 - Better than the HOT options
 - Help bypass the most congested areas
 - Good for high destination areas like the airport, Holcomb Bridge, Mansell
 - Massachusetts has it, and it works well
 - Very common in the Northeast
 - It would save gas (2)
 - Couldn't use it as a passing lane
 - That it would be two lanes (2)
 - Good if built new
 - Predictable
 - Good if there is a reversible lane to accommodate changes in traffic flows
 - Higher walls would reduce rubbernecking in case of an accident
- Dislikes:
 - You'd be stuck if there were an accident or you got caught behind a slow car (16)

- Harder for emergency vehicles (4)
- It could be hard to know if the exit you needed was actually an exit on the Express Lane, and people could get lost or confused (9)
- Concern about maintaining emergency/shoulder lanes (3)
- Wouldn't be very convenient for the way most folks travel—multiple stops/locations.
- How would we handle folks driving our roads from out of state? They could use the system for free (2)
- Police enforcement would slow traffic
- Would be hard for early users—if you miss your exit, how can you get back? (5)
- Not good for economic development—would enable folks to drive *through* and not have to “stop and spend”
- Harder to get off if kids have to go to the bathroom
- Wouldn't be used as much as HOT/HOV—less flexible
- Takes up too much space
- There could be weather issues if lane is elevated (i.e., could ice up before surface streets)
- Don't want to pay (2)
- Night-driving on an Express Lane would be unsafe
- Unless GDOT converts (or “takes”) and existing lane, construction will be needed (even if conversion, there will be some)—will cause congestion (2)
- More expensive to build and maintain- increased tolls
- 2 lanes would increase options for weaving

If an Express Lane was available and convenient for your commute and you were guaranteed that the speed on the lane would be 45–55 mph and speed on regular lanes is 25–30 mph, would you pay to use the lane?

The vast majority across all groups said “yes”

If you would not use the lane on a regular basis, are there any special times when you might pay to use it?

- Running late to work (2)
- Going to the airport (2)
- If going out of town (2)
- Fed-up with congestion
- “Time-sensitive” destinations may not work with Express Lane due to limited entry/exit points
- Medical emergency
- Sporting/special events

- To avoid an accident
- If I have 3 or more in the car and can use it for free
- In poor weather

If we were to build Express Lanes in the region, should carpools be allowed to use the lanes for free? If so, 2-person carpools or 3-person carpools or both?

The groups mostly agreed that 3-person carpools should be allowed to use the lane for free. Many groups also said that 2-person carpools should also be free.

Should Express Buses be allowed to use the lanes?

- Most groups said 'yes'
 - Has to be some advantage for the Express Bus
 - Conditional on buses driving at prevailing speeds
 - Conditional on the amount of fare increase
- Reasons for No:
 - Concern about the size of the buses ("don't let the really big buses on the lanes")
 - Tendency of Express buses to either drive too slowly or "crazy"
 - Buses seem to break down a lot, and that could cause congestion
 - Buses are hard to see around

Toll Collection Technology Questions

24. If so, what did you like or dislike about using (the Cruise Card on GA 400)? (Asked to FG #5 - 8)

- Convenient, easy to use, recharge (4)
- Receive an e-mail after account is charged
- Customer service is very good
- Don't need change to pay toll
- Don't have to stop to pay toll
- Can use Cruise Card for my parking deck as well

33/28. What do you think are the privacy issues related to these technologies (transponder, video tolling, GPS)? (Asked to FG #1-8)

- Transponder:
 - In general, participants agreed that there were fewer privacy issues related to the transponder than with other toll collection technologies. Consistent concerns

included **the tracking of personal travel behavior on toll roads, police getting access to information on personal travel behavior, and the possibility of someone hacking into your account or stealing the transponder and running up toll charges.**

- Less or no privacy issues (3)
- It tracks my travel behavior on toll roads (3)
- Police get access to information on my travel behavior, promote law enforcement? (2)
- Least invasive of all the options (2)
- Someone could “hack” into my account, steal transponder, and run up toll charges (2)
- Registration process could capture personal info, link to travel behavior
- Concerned that state won’t be able to manage effectively
- Like that it is portable
- **Video Tolling:**
 - Participants expressed privacy concerns about video-taping the car interior, the potential misuse of information due to the role of humans in taking, storing and reading the video, and fear that the information could be sold to various outside groups.
 - Don’t want video of inside of car (6)
 - Not a big deal—already doing it for red lights (2)
 - Human factor—people will be taking video, storing and reading it, they could misuse the info (2)
 - Don’t want the info be sold to various groups (2)
 - Could track my travel behavior on toll roads (2)
 - If my car is stolen, could be charged for someone else’s travel behavior
 - Could help with tracking stolen cars
 - Frees up police to do other work
 - Could catch someone with suspended license or insurance
 - Don’t want info shared with law enforcement (seat-belt violation, cell phone, etc.) (3)
- **GPS:**
 - The primary privacy concern here focused on **anxiety about the tracking of personal driving behavior**, whether it would be used in marital disputes or could be extended beyond the toll road itself.
 - Could track my personal driving behavior (10)
 - Could be used in marital disputes
 - Could track behavior *after* I’ve left the tolled road

- Could sell info about my personal driving behavior to outside organizations (marketing)
- Could share info with law enforcement - bad
- Good if info used in other law enforcement situations (i.e., Amber Alerts)
- More room for error than with transponder, VToll
- Would need an “opt-in” rather than an “opt-out” approach
- GPS Positives/Questions
 - Data could be used for transportation planning
 - Data could be used for location decisions for medical facilities
 - Could help in emergencies
 - Could it be retrofitted in older cars, or only available to new car owners?
- For all methods:
 - Would be vulnerable if you used your credit card to pay
- General questions:
 - How would each system deal with temporary tags?
 - Would there be a paper trail to document my use of the toll road?
 - Could I get an on-line transaction history if I wanted to dispute a fee?
 - How can drivers remember how fast they are going?

Enforcement Strategy/Technology Questions

29/29a. What do you think you would like or dislike about using video enforcement for handling toll payment violations (having a picture taken and receiving a mail-in ticket)?

- Like:
 - The most consistent positive responses to this question included confidence because the region has experience with the technology due to its use in red-light violations, confidence that it would positively impact driver behavior, and appreciation for video’s efficiency and it’s potential for revenue generation.
 - We have experience with the technology (3)
 - Not expensive to implement
 - Makes me confident
 - Could lead to better driver behavior (2)
 - Efficient - would catch more violators than cops do! (2)
 - Good for local governments—more revenue (2)
 - Deter cheating the system
 - Saves on police time/dollars—could be doing other things
 - Would create jobs—folks needed to look at video
 - Seems reasonable

- Low manpower requirement
- Better for toll violations than for red lights
- Picture is good evidence of violation
- Would be consistent
- Dislike:
 - The most consistent negative responses included a concern about the challenges of recourse if one is improperly identified, a concern about charging the owner rather than the driver of the car, and a general concern about inaccuracy.
 - Hard to get recourse if you are improperly identified (3)
 - Charging the owner, not the driver (2)
 - Concerns about level of inaccuracy (2)
 - Potential failure points at camera, DMV or communication between the various pieces of the enforcement picture
 - Too much Big Brother already
 - Would rather pay for more cops on the road
 - How to deal with out-of-towners—access to other state's DMV databases?
 - Problems with these cameras vis-à-vis red light violations (unidentified), could be replicated here

30/30a. “What do you think you would like or dislike about using video enforcement for handling vehicle occupancy violations (having a picture taken and receiving a mail-in ticket)?”

- Like:
 - The only answer that came up in more than one focus group was an appreciation that the video could be used by law enforcement to identify other violations (i.e., seat-belt violations).
 - Good for businesses with employees driving company vehicles—would show who exactly was the violator so company doesn't have to pay
 - Provides checks and balances for parents of teen drivers
 - Less disputable—either in the vehicle or not
 - More accurate than police
 - Less dangerous than police
 - Police should be freed up to deal with other crime
 - Can be used to track criminals
- Dislike:
 - The two responses that came up in more than one focus group included a concern about the difficulty of accurately assessing occupancy due to tinted windows or

passengers sleeping/bending down, etc. and a general privacy issue with the state being able to see inside vehicles.

- Privacy issue—don't like that they can see into the car (5)
- No cameras—use cops!
- Cameras need to be placed close together on the road to deter cheating (getting on and off the toll road without paying)
- Folks could use dummies to try to make a carpool—would cameras pick it up?
- Hard to get recourse if inappropriately charged with a violation
- Would take dollars for state to track down out-of-state drivers, could lead to higher tolls for all

31. What do you think you would like or dislike about using DTECH with infrared technology (also receiving a mail-in ticket) for vehicle occupancy violations?

- Like:
 - Five focus groups identified DTECH as being **better on privacy issues than video enforcement**; there were no other responses that came up in more than one focus group.
 - Better on privacy issues than video enforcement—anonymous (5)
 - Seems fair
 - More accurate than video
 - Easier to implement
 - Cheaters couldn't use dolls/dummies to game system
 - Infrared is used in other, non-transportation contexts—we know it works
- Dislike:
 - The only issue that came up in more than one focus group was a concern about the long-term impacts of infrared technology on human health.
 - Health concerns—what do we know about the impact of this technology on human health over the long term? (2)
 - Too expensive
 - Only 95% accurate in England—what's our recourse if we land in the 5%?
 - State can abuse it
 - Would infrared pick up and count pets in the car?
 - Fairly new technology - more room for error
- General Comments/Questions
 - Does it cost more/same/less than video?

34/34a. What do you think you would like or dislike about this process for handling double white line violations (having a picture taken and receiving a mail-in ticket) as is done for red light camera tickets?

- Like:
 - In general, the groups saw the same issues in terms of white line violations as were identified for toll and vehicle occupancy violations.
 - Same issues as for toll and vehicle occupancy violations (2)
 - Help raise revenue (2)
 - Would reduce weaving, cut down on accidents
- Dislike:
 - In addition to identifying the same issues that were raised in toll and occupancy violations, participants in two focus groups expressed concern about **the number of cameras that would be necessary to actually catch drivers crossing the double white line.**
 - Same issues as for toll and vehicle occupancy violations (2)
 - Need a lot of cameras to catch people (2)
 - What if I have to get off the lane due to an emergency, and there are no dashed lines?
 - Hard to get irregular users to understand dashed lane requirements
 - If enforcement is too strict, could scare folks away from using managed lane
 - Expensive—would need cameras and folks to read the video
 - May violate privacy by accident
- General comments:
 - Should be exemptions for certain road conditions (safety issues, accidents, etc.)
 - You'd need multiple pictures to show movement
 - Tolls should be higher for double-white line violations
 - Would need good public education about the double-white line rule

37/32/24. If Commuter Credits were implemented, would this make managed lanes more fair? How so?

Most focus groups responded with a straight “yes/no” vote, and did not expand on the question. Three groups rejected the notion that there was any link between fairness and the Commuter Credits program.

- Doesn't have anything to do with fairness (3)
- Only fairer for some, as many workers aren't allowed to telecommute or change hours
- Wouldn't be fairer—we'd still be sacrificing by having to change our travel behavior

Issues of Fairness and Potential Burdens Questions

41/35/25. What is fair or unfair about managed lanes?

- **HOV:** Several groups agreed that the HOV lanes were generally fair.
 - Generally fair (4)
 - Unfair to those who can't carpool because of job limitations (no flex time, no fixed location, etc.)
 - Unfair because they are still congested
- **HOT/VP HOT:** The most consistent response to this question was a concern over the regressive nature of the toll, followed by concerns about workers who cannot form carpools (job structure, housing location, etc.), an assertion that the toll represents double-dipping, as roads are already paid for by the gas tax, and a concern for folks who are currently using the HOV lane for free.
 - Harder on folks with fixed, lower incomes - regressive (10)
 - Unfair to folks who can't form carpools (job structure, housing location, etc.) (3)
 - The toll represents "double-dipping," because we already pay for the roads through the gas tax (2)
 - Unfair to folks already using the HOV for free (2)
 - If someone is working more than one job, would cost them more to travel
 - VP less unfair than straight HOT, as you have the option of paying less
- **Express Lanes:** Again, the only consistent response to this question is a concern for the regressive nature of the toll.
 - Lower income folks may not be able to afford tolls (7)
 - Unfair to folks for whom limited entry/exit points aren't convenient
 - Harder to plan or budget for travel, difficult for lower-income folks
 - Fair because it's a new item—not taking something away now given for free
- **General Comments/Questions:** The most consistent comment was the assertion that the lanes were generally fair because **if overall congestion (in both managed and general purpose lanes) is reduced, everyone benefits**. Additional fairness concerns included the **more limited carpool options available to disabled drivers due to accessibility issues**.
 - If managed lanes do reduce overall congestion, all will benefit, even those who can't use the lanes themselves (6)
 - Using the lanes is voluntary—fairness not an issue (2)
 - All lanes may be unfair to disabled, as they have more limited carpooling options due to accessibility issues (2)
 - Luxury item—folks paying for convenience of faster travel times—"Lexus Lanes" (2)
 - You can pay as you need it

- Could be unfair to parts of region that don't get managed lanes first, they have to suffer congestion longer
- Children shouldn't count towards a car-pool—don't get cars off the road
- All lanes may be unfair to seniors on fixed incomes

Final Reactions—“Big Take Aways” Questions:

7/38/28. If yes, what are the incentives offered by your employer (for the Clean Air Campaign)?

The most consistent responses included **subsidies for MARTA cards/ tokens, and payments and other incentives for carpooling,**

- Subsidy for MARTA cards/tokens (7)
- Payments/gift cards/other incentives to carpoolers (4)
- Free steak dinners for highest hours in program
- Discounts on transit (2)
- Free MARTA pass (2)
- Telecommuting options (2)
- Provides shuttle buses/vans (2)
- Centralized carpool coordination (2)
- Pre-tax deductions for transit costs
- Showers and lockers at workplace for bikers
- Reimbursement for bus passes (50% and 100%)
- Employees paid to carpool - \$3/day for the first 90 days
- 4-day work week in summer
- Carpoolers get free garage parking at work
- Encouragement to work flexible hours
- Extra vacation days if you come in before or after peak period
- Subsidized van-pools
- Free pedometers
- Parking prices higher in summer as incentive to car-pool

39. Would you be likely to change your commute times to avoid tolls? Why or why not? If so, how would you change your time?

Few focus groups expanded upon their “yes/no” votes on this question. For those who did, the answers are listed in order of frequency below.

- Leave for and from work earlier (3)
- Whenever it made sense on any given day (2)

- Leave for and from work later (1)

40. Would you be likely to change your commute routes to avoid tolls? Why or why not? If so, how would you change your route?

Few focus groups expanded upon their “yes/no” votes on this question. For those who did, the majority responded that they would **take the back roads/surface roads.**

- Take the back roads/surface roads (6)
- Whatever is most efficient on any given day
- Try I-285 versus I-85
- Would depend on how much extra time, level of toll, extra gas needed

41. Would you form a carpool in order to take advantage of faster travel times at reduced toll prices? Why or why not?

Few focus groups expanded upon their “yes/no” votes on this question. The answers are listed in order of frequency below.

- Yes:
 - To save money (2)
 - To save gas
 - If there were designated pick-up and drop-off spots
- No:
 - Not practical to pursue carpools as major congestion relief in region—folks won't carpool! (2)
 - Not as dependable, less freedom and flexibility
 - My hours are too variable

42. Would you take an Express Bus in order to take advantage of faster travel times in the managed lanes? Why or why not?

Few focus groups expanded upon their “yes/no” votes on this question, and there was little consistency when they did.

- Yes:
 - Would depend on cost of the fare
 - Would save me gas
 - Drive less
 - Safer
 - If it was convenient
- No:
 - Less convenient (2)

- Have to do stuff during the day—need my car while at work
- Waiting at bus stop
- Can't carry as much with me (car as storage)
- Have to talk with people

46/43. What other ways should the region consider to reduce congestion?

- MARTA/Transit Issues
 - Build more MARTA throughout the region (9)
 - Expand to Mall of GA on 85
 - Increase reliability
 - Tunnels for transit?
 - Build more “park-n-ride” lots
 - Faster travel times on MARTA
 - MARTA and rail, not bus system
 - Need a transit option between 75 and 20—like an outer Beltline, bring transit to the northern suburbs (2)
 - Expand MARTA into south of downtown
 - Culture change to support more transit
 - Create monorail system (2)
 - MARTA should be absorbed into GRTA
 - Expand system to all major spokes around the Perimeter
 - Help MARTA cross jurisdictional lines
 - Integrate all bus systems
 - Help leverage state and federal transportation dollars
 - Increase efficiency and coordination between transit systems in the region
 - Put transit close to where folks live
 - Expand Express Bus schedules—need more buses outside of commuting times, after 9:00 p.m.
 - Express buses with dedicated lanes
 - Use freight rail more
 - Provide free transit
 - Use extra revenue from tolls for rebates to transit users
- Regional Growth Issues
 - Slow growth in the region to reduce congestion –all else is a band-aid (5)
 - Encourage jobs/housing balance—traffic prevention (2)
 - Development patterns too spread out
- Road Construction/Maintenance/Other Issues
 - We need an outer Perimeter (4)

- Build more lanes (4)
- Use green light/red light system for getting on all highways (2)
- Fix signalization (2)
- Build tunnel for long-distance commutes
- Provide more HERO units for all roads south and north of 285
- Widen GA 400
- Finish existing projects—will reduce congestion
- Explore building tunnels for cars
- More signs/online/radio info about road conditions, alternative routes
- Focus on fixing travel hot-spots
- Fix the lanes we've got
- Trucks
 - Congestion largely due to trucks: (4)
 - Dedicated truck lanes (esp. 18-wheelers)
 - Truck moratoriums by day, time of day, by lane
 - Get trucks off the highway
 - Use railroads to move trucks through the region
- Miscellaneous
 - Allow hybrid/electric cars and motorcycles access to managed lanes
 - GDOT should plan 10-20 years into the future instead of offering band-aid solutions
 - Have government workers change their work schedules, commuting patterns
 - Deal with slow drivers
 - More drivers education, enforcement re: safe driving will cut congestion
 - Make entry/exit off toll roads easier—don't cross GP lanes
 - Allow folks to deduct tolls from state taxes—self-employed and regular
 - Make it harder to get drivers licenses—less cars on road
 - Focus Group Summary Results—Quantitative Questions

Summary of Pre- and Post-Focus-Group Surveys

Participants in the focus groups were asked to complete a pre-survey when they arrived at the facility to participate in their focus groups. The pre-survey contained questions related to standard demographic characteristics as well as questions related to their current commute experiences. After the focus group activities were complete, these 182 participants were asked to complete a post-survey, which contained follow-up questions on managed lane preferences, thoughts about enforcement concepts, and Willingness-to-Pay questions related to their potential interest in using tolled managed lanes should they be constructed in the region. Not all participants answered all of the questions. The survey is contained in Appendix G.

Commute Conditions

According to the survey responses, more than 95% of the participants regularly use the freeway system to get to and from work. About 81% of the 175 participants that answered this question reported that they take the same route to work and home from work. The fact that 19% of the participants regularly take different routes to and from work is of significant interest from a travel behavior perspective. There is insufficient information in the data collected during the focus group study to evaluate why there is such a significant difference; however, further studies in this area are warranted with respect to potential impacts of pricing and managed lane implementation.

More than half of the participants (56%) reported that their freeway travel route to work is always congested, and an additional 40% report that their route is sometimes congested. More than two-thirds of the participants stated that they would depart home for work later than they currently do if congestion were not present on their commute route. On the return trip home, 54% reported that their freeway travel route home is always congested, and an additional 42% report that their route is sometimes congested.

More than 60% of the participants reported that their journey to work, and 68% of the participants reported that their journey home from work, are unusually congested more than 5 work days per month. Travel time variability is often identified as an indicator of quality of service, where uncertainty associated with arrival time is considered to be a negative quality indicator. About half (48%) of the participants indicated that their travel time is consistent, 21% report that travel time varies somewhat, and 30% report that travel time varies a lot. On the trip home, 37% of the participants indicated that their travel time is consistent, 18% report that travel time varies somewhat, and 42% report that travel time varies a lot. Travel time variability for these participants is significantly heavier on the trip home than on the way to work. Approximately 31% of the participants believe that it is more important to improve the reliability of their travel time to and from work than it is to reduce their total commute travel time.

More than 96% of the participants have used the HOV lanes in Atlanta at one time or another. Of the 182 focus group participants, 24% use the HOV lanes on a regular basis. However, this is because two of the focus groups were composed of express buses riders and one was composed of carpoolers. Of the participants in the 16 regular commuter focus groups, only 13 of the 152 regular commuters (9%) use the carpool lanes on a regular basis.

Participants were asked to estimate the amount of time that they would save on their journey to and from work if the freeways were moving at a minimum of 45-55 mph. On the journey to work, 56% estimated they could save more than 15 minutes, 14% estimated they could save 30 minutes, and 8% indicated they could save more than 45 minutes. On the journey home from work, 64% estimated they could save 15 minutes, 22% estimated they could save 30 minutes, and 8% indicated they could save more than 45 minutes. As expected, given noted traffic conditions on Atlanta regional freeways, participants reported greater congestion on their trip home than on their trip to work.

After being presented with a description of HOT lanes functionality, 71% of the focus group participants indicated that they would pay to use a HOT lane for their commute if guaranteed minimum speeds of 45-55 mph were maintained. There was no significant difference (69%) with respect to acceptance of variably-priced HOT lanes. Participants in the three low-income focus groups (30 participants) stated that they were less-likely to use HOT lanes on a regular basis, with 43% of these participants reporting that they would do so. Similarly, 72% of participants indicated that they would use an express lane if it were available (50% for the low income groups).

Focus Group 5 was specifically dedicated to carpoolers, and Focus Groups 10 and 16 were dedicated to transit riders (about 17% of the sample). Of the rest of the sample, 83% of the households never carpool, 5% reported that they carpool more than 5 work days per month, and 3% reported that they carpool more than 10 work days per month. On their journey home from work, 38% indicated that they could save time using the carpool lane, 20% reported that the carpool lane is so congested that they would not save time on their journey to work, and 42% did not have a carpool lane to use (2% did not respond)¹. Further analysis of journey to work route will likely reveal that these participants use the specific freeways where ITS data indicate that the carpool lane routinely becomes congested. Of the 27 carpoolers, 7 specifically stated that even though they do carpool, they never use the carpool lanes because they lanes are too congested. When the non transit and non carpool participants were asked whether carpools composed of a parent and one or more children should be treated as work carpools, 37% indicated that they should not.

¹ The journey to similar journey to work response was not reported here because the question did not provide for a “no carpool lane available” answer, and participants may have answered hypothetically with respect to carpool lane time savings.

Carpool discounts were addressed in the focus groups. With a show of hands, 76% of the 182 total participants indicated that 2-person carpools should be provided a discount for using HOT lanes. The same response (75%) was noted for the regular commuters that do not currently use express buses or carpool regularly. Interestingly, only 47% of the 30 low income commuters indicated that 2-person carpools should receive a discount. Despite the high-percentage of participants indicating that carpools should receive a discount, only 26% of the regular commuters (and 20% of the low income commuters) that do not currently use express buses or carpool regularly indicated that they would consider forming a carpool in order to take advantage of the discount. It may be that it is more difficult for low income households to form carpools, given the nature of their employment. Additional research on this aspect seems warranted. With respect to formation of 3-person carpools, 16% of participants indicated that they would consider forming or joining a carpool to take advantage of the free tolls.

In covering express lanes, participants were asked in a different way whether carpools should receive a discount. They were first asked whether 2+ -person carpools should receive a discount and then whether 3+ -person carpools should receive a discount. Of all participants, 54% indicated that 2+ -person carpools should receive a discount, 39% indicated that 3+ -person carpools should receive a discount, and 6% indicated that no users should receive a discount (all vehicles pay the same toll). The responses were very different for the 30 low-income participants, where 20% indicated that 2+ -person carpools should receive a discount, 63% indicated that 3+ -person carpools should receive a discount, and 17% indicated that no users should receive a discount. Based upon the focus group responses, it might be wise to revisit the presumption that implementation of carpool discounts on managed lanes is advantageous to (and desired by) to low income users. Further study of such impacts certainly seems warranted.

When asked if organized drop-off or pickup locations would make them more likely to form a carpool or ride in a carpool, 14% of the regular commuter participants indicated “yes,” 79% indicated “no,” and 6% did not vote.

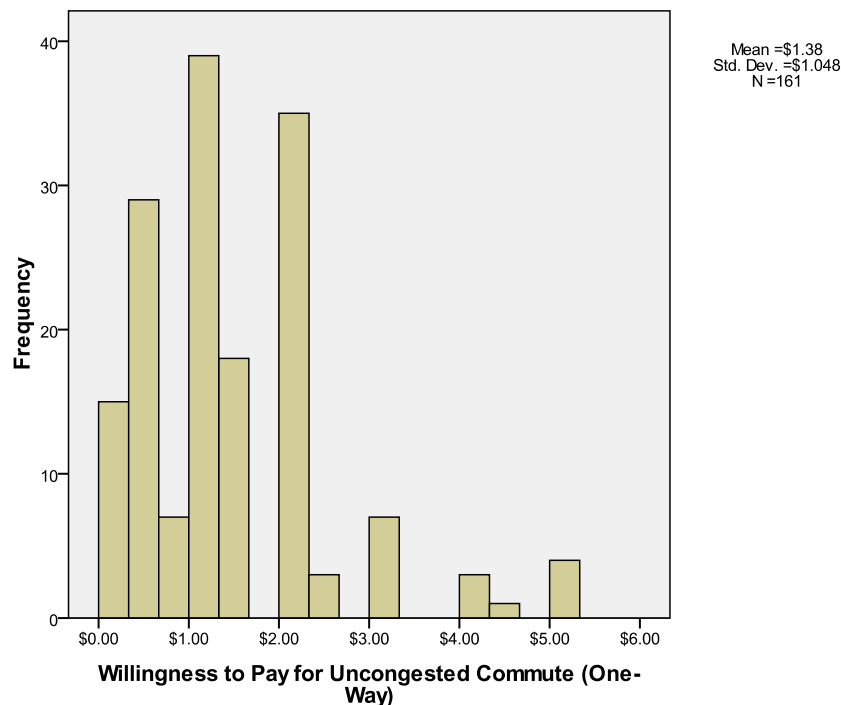
Express bus use of managed lanes was well-supported by focus group participants. More than 70% of participants indicated that express buses should be allowed to use such lanes (87% of low income participants).

The vast majority of the participants (90%) indicated that they would be willing to pay a refundable deposit of \$5 - \$10 to receive a transponder card for use on a managed lane. Even the 30 participants in the low income groups indicated a 79% willingness to do so.

Willingness-to-Pay Survey Response

Participants were asked an open-ended question about how much they would be willing to pay to use a managed lane that guaranteed a minimum speed on their commute of 55 mph. Participants could write-in any price that they felt was appropriate. Figure 2 contains the Willingness-to-Pay histogram for the 161 participants that responded to this question. The mean Willingness-to-Pay for a commute trip at 55 mph was \$1.38, with a standard deviation of \$1.05. The 95% interval around the mean was \$1.22 to \$1.55. That is, we are 95% confident that the true mean value for the sample lies between \$1.22 and \$1.55, with no individual value within that interval being any more likely to be the true mean than any other value. Individual stated Willingness-to-Pay values ranged from \$0.00 (10 participants were not willing to pay anything) to \$5.00 per trip (4 participants).

Figure 2: Willingness-to-Pay Histogram for Managed Lane Use at a Stipulated Guaranteed Speed of 55 mph



The 161 participants that responded to the Willingness-to-Pay question represented a wide cross-section of demographic characteristics (income, gender, family structure, race, etc.), employment classifications, etc. These analyses are reported in the sections that follow.

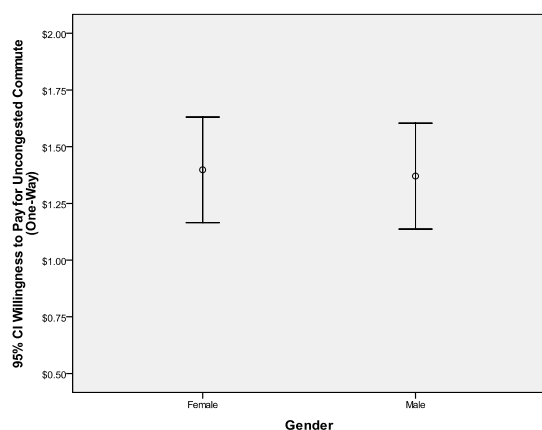
WTP by Gender and Household Structure

The Willingness-to-Pay responses were first compared across the standard demographic parameters of gender, marital status, total household size, and number of children in the household. In the sample:

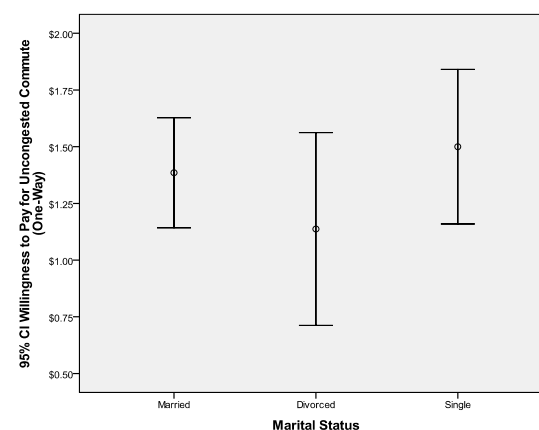
- 50% were female and 50% were male
- 29% were single, 57% were married, and 14% were divorced
- 21% were 1-person households, 31% were 2-person households, 21% were 3-person households, 15% were 4-person households, 8% were 5-person households, and 4% were larger
- 59% had 0 children, 21% had 1 child, 11% had 2 children, and 6% had 3 children, and the 3% had 4 children

Error bars, representing the 95% confidence intervals around the mean response for each classification criteria are presented in Figures 3 through 6. As before, each error indicates that we can be 95% confident that the true mean Willingness-to-Pay for that group lies somewhere within the error bar. When these error bars overlap, we cannot state that the mean values are significantly different from each other. Error bars can be wide if sample sizes are small or if the variability in response inside the sample is large (with some participants indicating they are willing to pay very little and others within the same sub-sample indicating that they bare willing to pay a lot). In these cases, sample sizes are reasonably large (except for large household size and number of children), and the error bar size is predominantly the result in response variability. The error bars range from \$1.10 to \$1.80 and the error bars all overlap, meaning that the mean response across each group is not statistically significantly different than any other group. For the survey results, we did not observe any significant difference in the Willingness-to-Pay by gender, marital status, household size, or number of children.

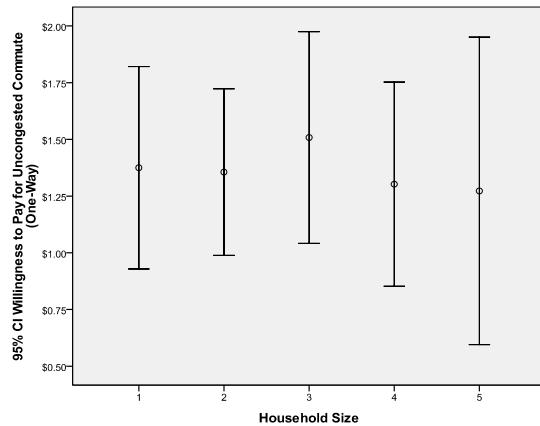
**Figure 3: Willingness-to-Pay Error Bar Plot
by Gender**



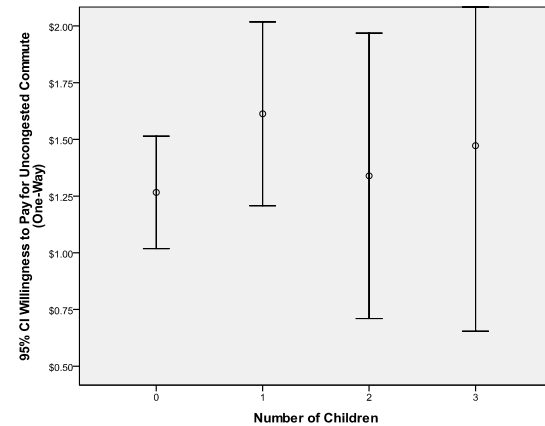
**Figure 4: Willingness-to-Pay Error Bar Plot
by Marital Status**



**Figure 5: Willingness-to-Pay Error Bar Plot
by Household Size**



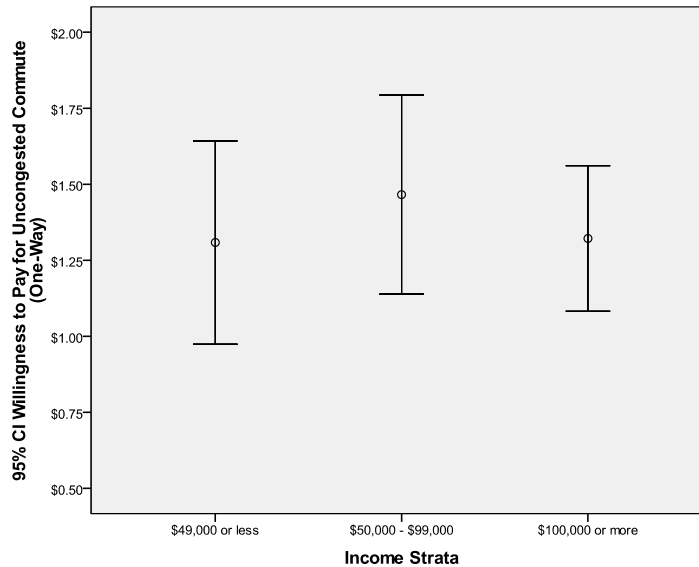
**Figure 6: Willingness-to-Pay Error Bar Plot
by Number of Children**



WTP by Income Group

Of the 145 participants who provided income data, 28% were in the low income group (\$0 to \$49,999), 37% were in the middle income group (\$50,000 to \$99,999), and 35% were in the highest income group (\$100,000+). The interesting aspect with respect to income is the lack of any statistically significant difference in the average willingness to pay for uncongested travel across these groups. Conventional wisdom is that lower income households will have a significantly lower Willingness-to-Pay than middle and upper income households. However, the focus group data indicate that the mean values are very close across these groups, and the variance in the mean response is really not very different across these groups. Contrary to expectation, the mean Willingness-to-Pay value is slightly higher in the middle and lower income group than the higher income group (but not statistically different).

**Figure 7: Willingness-to-Pay Error Bar Plot by Income Group
for Managed Lane Use at a Stipulated Guaranteed Speed of 55 mph**



Education Level

Another potential grouping besides income that could affect willingness to participate in toll-style managed lane facilities is education level. The presumption is that individuals with higher education levels may have different employment classifications, and thus may be more amenable to toll payment.

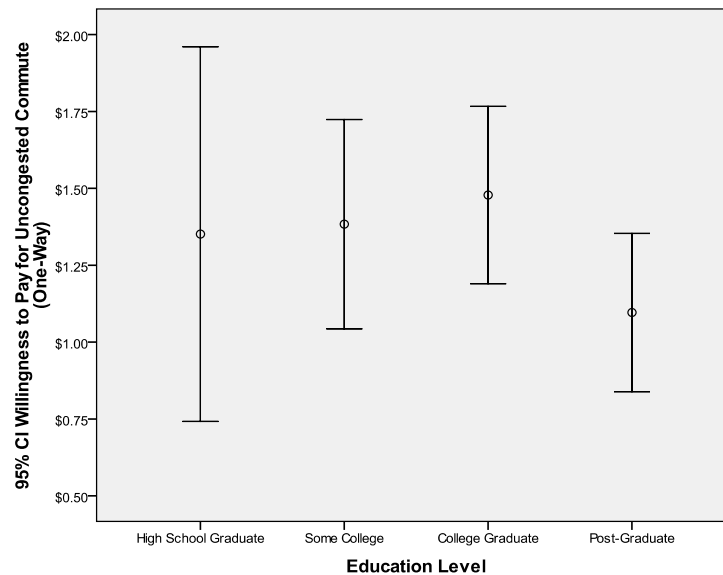
Table 3: Education Level Reported by 145 Focus Group Participants

	Percent
High School Graduates	10%
Some College	29%
College Graduate	44%
Post-Graduate	18%

No statistically significant difference in the Willingness-to-Pay for uncongested trips was noted across these four education levels (see Figure 8). The high-school education-level group contained only 17 participants, so it is not surprising that the confidence interval is largest for this group. However, the means are roughly the same, and the range is not much wider than that of the other groups. There appears to be no significant differences in Willingness-to-Pay across the participants based upon their education level. The lowest Willingness-to-Pay reported by those with Post-Graduate education might be

indicative of more flexibility in work hours available to that category of responders, which results in less reliance on the freeway travel during the peak periods.

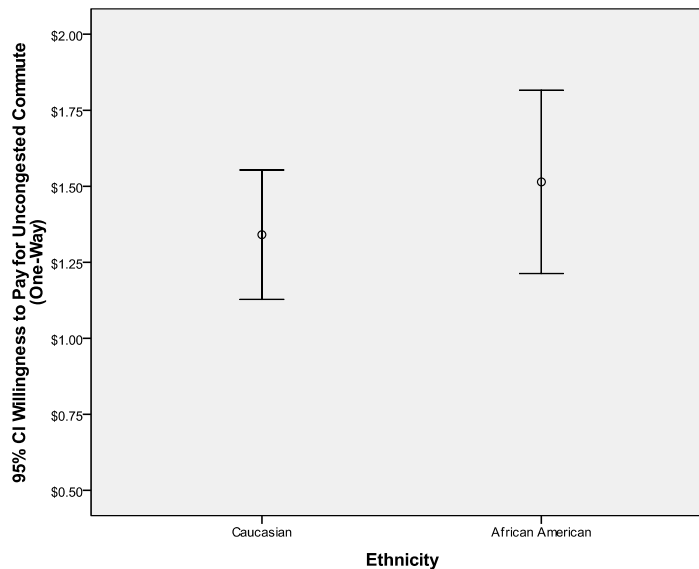
**Figure 8: Willingness-to-Pay Error Bar Plot by Education Level
for Managed Lane Use at a Stipulated Guaranteed Speed of 55 mph**



WTP by Ethnicity

Of the participants who completed the surveys, 62% were White/Caucasian, 31% were Black/African American, 7% were Latino/Hispanic, Asian/Pacific Islander, or Other Race. The Latino/Hispanic and Asian/Pacific Islander samples were too small to obtain reliable confidence bounds. However, the White/Caucasian and Black/African American samples were large enough to compare. Black/African American participants were willing to pay slightly more per uncongested trip; however, there was no statistically significant difference between the values (see Figure 9).

**Figure 9: Willingness-to-Pay Error Bar Plot by Ethnicity
for Managed Lane Use at a Stipulated Guaranteed Speed of 55 mph**



WTP by Employment Locations

Interestingly, 20% of the focus group participants reported having more than one job (although only 7% of these second jobs were paying jobs). However, no statistically significant difference in average Willingness-to-Pay for an uncongested commute was observed across number of jobs (see Figure 11). Part time workers on average reported a lower willingness to pay, but again the difference was not statistically significant. Similarly, no statistically significant difference in average Willingness-to-Pay for an uncongested commute was observed for number of worksites (see Figure 12). The reported job classifications of the participants included 26% sales or service positions, 12% clerical or administrative support positions, and 41% professional, managerial, or technical positions, and 13% other positions (insufficient data were available to examine manufacturing positions and students). No statistically significant difference was observed in Willingness-to-Pay across any of the job classifications (see Figure 13).

Previous studies have indicated that vehicles used for personal and commercial purposes make many more trips and travel more miles than those that are used for personal purposes only (Ogle, et al., 2008). There were also 18% of participants who indicated that they also use their vehicle for commercial purposes. However, no statistically significant difference in Willingness-to-Pay for uncongested trips was noted across these groups either.

Figure 10: Willingness-to-Pay Error Bar Plot for One or More Jobs

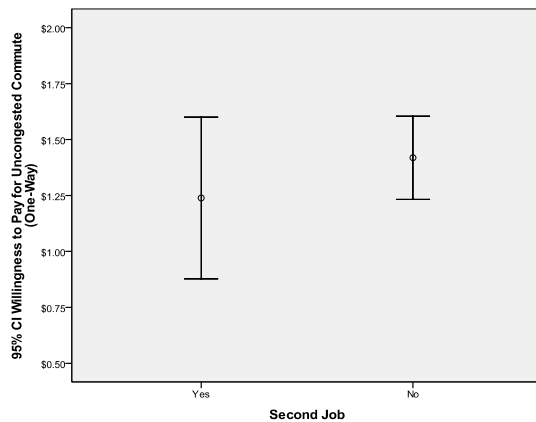


Figure 11: Willingness-to-Pay Error Bar Plot for Full, Part-Time, and 2+ Paying Jobs

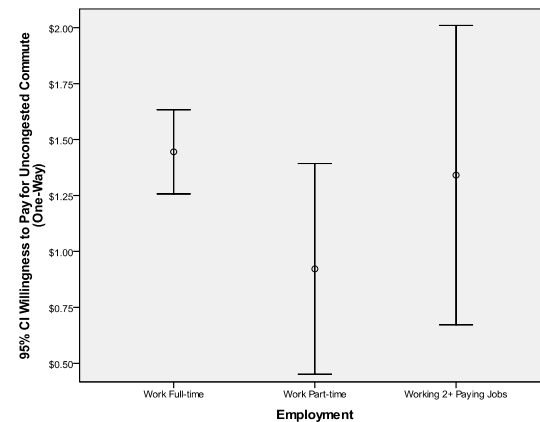


Figure 12: Willingness-to-Pay Error Bar Plot for Multiple Work Locations

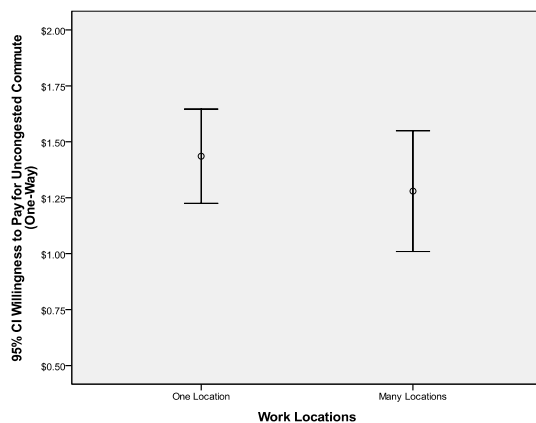
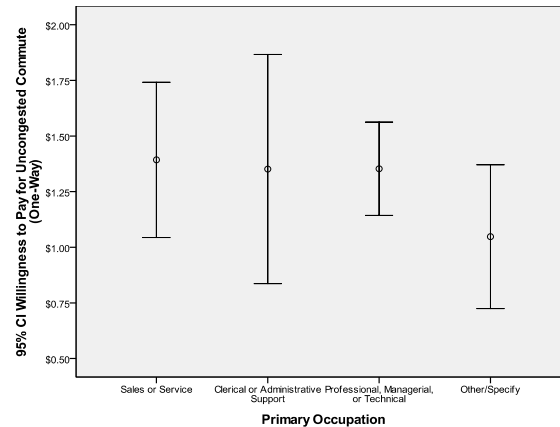


Figure 13: Willingness-to-Pay Error Bar Plot for Job Classifications



Parking

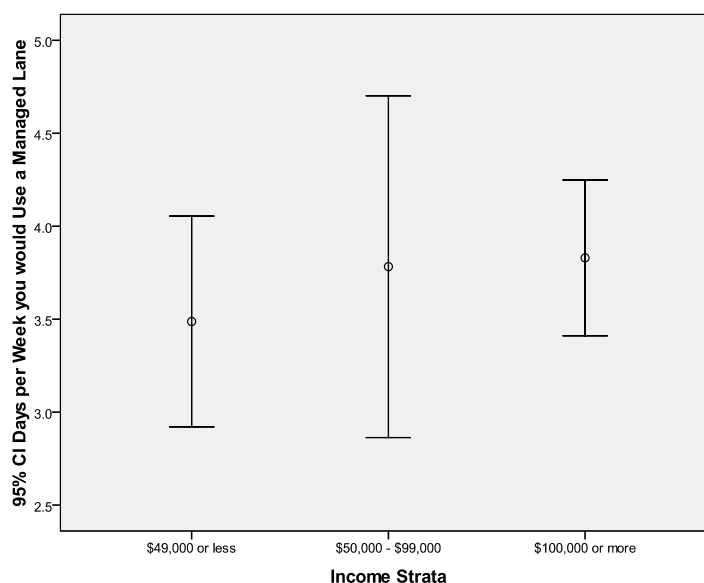
Approximately 80% of the focus group participants pay nothing for parking at work, 16% pay more than \$20/month, 13% pay more than \$50/month, and 10% pay more than \$100/month. There was no statistically significant difference in the stated Willingness-to-Pay across these groups.

Willingness-to-Pay Summary

Contrary to conventional wisdom, the written pre- and post-surveys completed by the 182 focus group participants for willingness-to-pay did not identify any differences in the mean willingness to pay for use of tolled managed lanes across any demographic group (including household size, income, and ethnicity), or across any employment condition examined. These findings are especially relevant in light of potential

equity impacts upon the driving population. Given that use of managed lanes involves a choice to pay for improved service, and given that the implementation of managed lanes will not degrade existing service on general purpose lanes, the willingness-to-pay results indicate that disadvantaged groups (as represented by income and race) stand to benefit from the implementation of managed lanes and appear willing to pay the same amount for achieving these benefits. In addition, when asked to report the number of days/week that the participant would use the managed lane at their specified price, no statistically significant difference was identified across income group (see Figure 14). Even the participants in the lower income group report an average expected lane use of 3.5 days/week, at an average one-way price of approximately \$1.30 per trip (see Figure 7 shown earlier). This amounts to annual toll commitment of more than \$450/year.

Figure 14: Expected Managed Lane Use (Days/Week at Self-Reported Price)



Doubling the Fare

Participants were also asked to envision a managed lane system that cost twice what they reported as their stated Willingness-to-Pay per trip. More than 70% indicated that they would still be willing to use the lanes under certain conditions. Participants reported that they would pay more for: travel when they are late to work, trips to the airport, attendance of sporting events, avoidance of severe crash congestion, travel to important meetings, doctor appointments, emergencies, vacations, and similar examples. If the focus group participants are representative of the opinions throughout the region, the market for managed lanes that involve tolling appears to be significant in the Atlanta metro area.

Ranking of Managed Lane Type

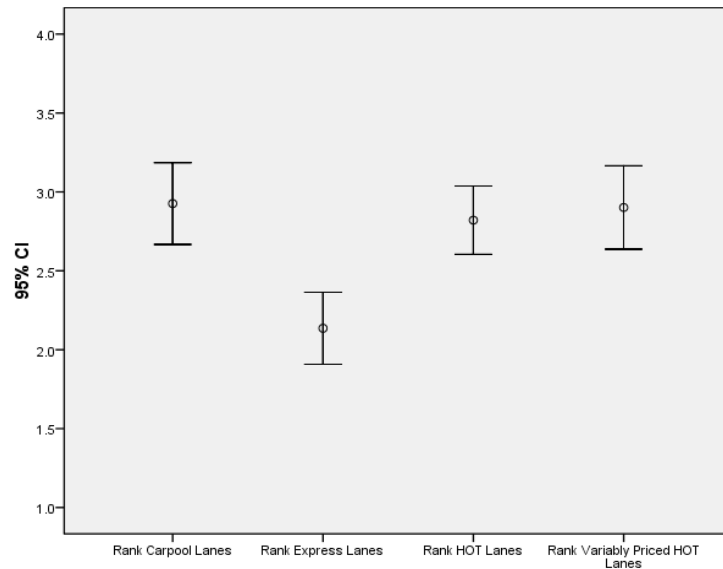
Participants were asked to rank-order their preference for the implementation of managed lanes, from 1 (most preferred) to 4 (least preferred) for each of the four types of managed lanes systems (carpool lanes, express lanes, HOT lanes with fixed price, and HOT with variable price). 150 participants completed these questions. As might be expected, a significant number of participants did not follow the survey instructions and either ranked only one choice as 1, or ranked multiple choices with the same value. Hence, the percentage ranking by score cannot be reliably provided. However, the number of votes by top value (ranked as a “1”) and by bottom value (ranked as a “4”) for each alternative does provide useful information (see Table 4).

Table 4: Focus Group Post Survey Managed Lane Highest and Lowest Rankings

	Carpool Lanes	Express Lanes	HOT Lanes	Variably-Priced HOT Lanes
Number of Top Rankings (1)	40	82	17	39
Number of Bottom Rankings (4)	56	27	25	46

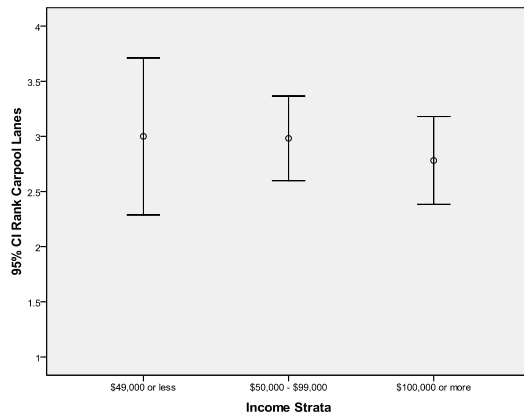
Express lanes are the preferred type of managed lane system, with the largest number of top rankings and least number of bottom rankings. Variably priced HOT lanes are generally preferred over carpool lanes based upon the straight numbers. The rating scheme is ordinal, with the lowest reported value being equal to the highest preference. Hence, comparisons of mean ratings for each managed lane alternative are valid. More detailed analysis indicated that there was a large amount of variability in the rankings. However, as can be seen in Figure 15, the differences in the average rankings were statistically significant for express lanes.

**Figure 15: Rankings of Managed Lane System Type
from 1="Most Preferred" to 4="Least Preferred"**

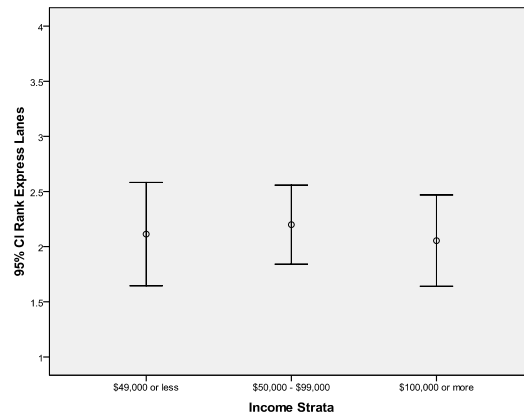


To examine whether there was any significant relationship between preference ranking and income level, another basic error bar analysis was performed. Although the average ranking for HOT lanes was slightly lower for lower income participants, as seen by the higher values in Figure 16, no statistically significant difference were noted in the rankings across income. No statistically significant difference was noted across ethnicity or gender group either (figures not shown).

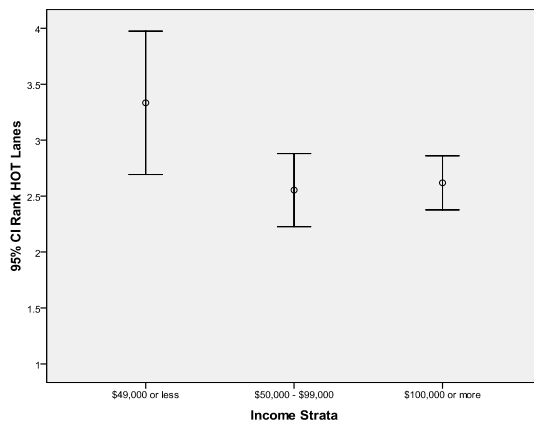
Figure 16: Error Bar Plot of Focus Group Post Survey Managed Lane Rankings



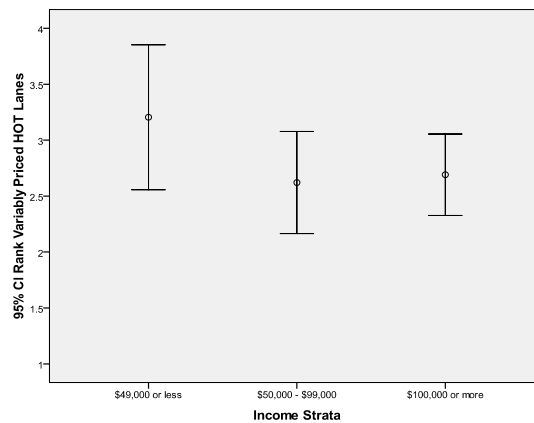
**Carpool Lane Ranking
By Income Group**



**Express Lane Ranking
By Income Group**



**Fixed-Price HOT Lane Ranking
By Income Group**



**Variable-Price HOT Lane Ranking
By Income Group**

In moving forward with managed lanes plans for the region, there appear to be three take-away messages from this section of the post focus-group-survey: 1) if funding is available to purchase and develop separate right-of-way, metro users would most likely prefer to implement express lanes, 2) if express lanes are impractical, metro users are no less supportive of the implementation of HOT lanes than they are of the implementation of carpool lanes. In any case, there appears to be no significant difference in the preferred system rankings by income, gender, or ethnicity.

Enforcement Penalties

Of the 182 participants, 180 answered the post-focus-group survey enforcement questions and indicated that enforcement penalties should be imposed for violations of HOT/Express Lane operating conditions (failure to pay, failure to merge in proper areas, or failure to meet minimum carpool requirements). More than 55% of the participants indicated that a fine of \$50 or less was appropriate, 22% stated \$100, 12% stated \$150, and 11% stated more than \$150. Participants overwhelmingly (94%) agreed that penalties should increase for repeat violations. In fact, 70% indicated that it would be fair to ban violators from renewing their vehicle registration until their fines were paid.

Toll Collection Systems

Participants in the Track A (tolling) groups (102 participants) provided responses related to what kinds of toll collection systems they would be interested in using on Atlanta's managed lanes. Two low income focus groups (19 individuals) also participated in Track A. When asked how they would prefer to pay their tolls, 27% indicated they would like to have the tolls direct billed to an existing credit or debit card, 54% indicated they would prefer to set up a separate account, and 21% indicated that they would like to be billed by mail. The low income group participants were nearly evenly split across these three options (32%, 37%, 31%). Given that it is very likely that separate accounts will be the option selected for Atlanta, participants were asked how they would prefer to add money to their toll account. The majority (79%) indicated they would prefer to add money online through an internet connection, 9% by phone, and 9% at a grocery store or other convenient retail location (the other 3% did not respond). The 19 low income group participants reported a lower preference for Internet (53%), and an increased preference for phone and retail locations (16%), with the other 16% not responding. It appears that Internet will be the primary means of choice for toll account payments, but that low income users will also likely need phone and retail location alternatives for adding funds to their account.

When asked whether managed lane participants would set up an anonymous account that does not identify them as the user of the transponder, 64% of participants indicated they would do so if such an option were available (79% of the low-income group participants).

Participants were presented with three toll collection technologies (transponders, license plate video tolling, and GIS-based tolling). The focus group participants overwhelmingly (85%) identified transponder technologies as their method of choice. An equal number of participants (7%) selected the video tolling and GIS tolling. The lower income group participants were split 95% transponder and 5% video tolling.

Enforcement Track

The enforcement track (Track B) included 80 participants. Only one of the focus groups in Track B was composed of low income individuals (11 participants). With respect to failure to pay tolls, 67% of the participants in Track B indicated that a photograph of the license plate was sufficient to demonstrate that a violation had occurred (all 11 of the low income participants concurred). However, only 44% of the 80 participants indicated that it was fair to ticket the vehicle rather than the driver (8 of the 11 low income participants), 39% indicated it was not fair, and 18% did not respond, for failure to pay a toll. Similarly, 49% of the 80 participants indicated it was fair to ticket the vehicle for vehicle occupancy violations (8 of the 11 low income participants).

On vehicle occupancy, 69% of the 80 participants would prefer a non-video infrared solution to confirming vehicle occupancy (10 of the 11 low income participants). Hence, video cameras shooting into the vehicle for occupancy detection purposes are generally not desired.

The participants were split 57% in favor to 43% against on the question about whether carpools should be required to use dedicated carpool transponders.

A subset of 35 of the 80 Track B participants was asked whether ticketing the vehicle rather than the driver on the basis of a video-captured license plate was acceptable for double-white-line crossing violations. The alternative “no” answer meant that the participant agreed that an actual photo of the driver should be required and that the driver rather than the vehicle should be ticketed. On double-white line violations, 57% of the participants said “yes” that a license plate photo was sufficient (rather than 44% for failure to pay a toll). However, all 11 of the low income participants said “no” and that a photo of the driver should be taken and the ticket should be issued to the driver. In part, this may relate to the amount of car-sharing that occurs within and across income groups.

Not all of the track B (enforcement) focus groups were asked all of the questions regarding whether it would be fair to ticket the vehicle rather than the driver under various conditions. Hence, it is not necessarily valid to compare percentage response results across all of the questions. There may be differences in the perceived acceptability of ticketing a vehicle for line violations compared to tolling and occupancy violations. Participants may also have gradually changed their opinion about ticketing vehicle rather than drivers as the questions progressed. However, the difference may simply be due to the smaller sample size. Additional surveys on the acceptability of ticketing a vehicle rather than the driver appear warranted.

Most of the Track B participants were asked whether a staggered system of fines should exist, where drivers pay the first fine in the form of an administrative penalty, with fines increasing with repeat

violations, and eventually a court appearance being required. Of the 58 that were asked, 52 (90%) indicated that fines should increase if drivers continue to violate system requirements. Low income drivers responded with the same 91% approval for the staggered fine system.

The enforcement focus groups were asked whether different types of violations should be considered “moving violations,” which would count as points against your license and potentially result in increased insurance costs. All 11 of the low-income group participants indicated that no violations of any kind should count as moving violations. This differs significantly from the 36% of the 58 general commuters (which only included some low-income drivers) who said that no violations should be considered moving violations. Of the general commuters, only a handful indicated that failure to pay tolls (5%) or carpool occupancy violations (2%) should be considered moving violations. However, 64% of the participants after excluding the low-income group indicated that illegal crossing of the double-white lines should constitute a moving violation as illegal weaving does constitute a safety hazard.

Commuter Credit Program

All of the focus group participants were presented with an overview of the Commuter Credits Program, in which commuters that take alternative modes of transit, telecommute, or commute off-peak can generate credits that allow them to occasionally use the HOT lanes without having to pay the toll. In essence, the Commuter Credits Program is a secondary financial incentive program to encourage alternative commute modes and reduce congestion on general purpose lanes. The cost of that program is essentially paid for by allocating some of the space on the HOT lanes for this purpose and slightly increasing the tolls for paying users of the HOT system (given that tolls are a function of demand for the lane and remaining capacity). Of the 182 focus group participants, 130 (71%) indicated that they would like to participate in the Commuter Credits Program, and 83% of the low-income focus group participants indicated that they would participate. Participants did not indicate strongly (only 46% of all participants and 43% of low-income participants) that the implementation of the Commuter Credits Program made HOT lanes “more fair.” Discussions circulated generally around the practical aspects of generating viable travel options and encouraging alternative modes.

Changes in Travel Behavior

Only 25% of the participants indicated that they would be likely to change their commute times in order to avoid managed lane tolls, whereas 45% indicated they would be likely to change their commute routes in response to toll pricing. The splits for the two low income groups were 37% likely to change departure times and 83% likely to change routes. Only 14% of the participants indicated that they would be likely to join or form a carpool in order to avoid managed lane tolls. Only one (5%) of the low-income focus group participants indicated they would be likely to join or form a carpool to avoid tolls. Again, the conventional wisdom or perception that low income drivers will be more likely to form carpools is one that should be

further investigated in another study for this corridor. Approximately 23% of participants who do not already ride an express bus indicated they would be likely to join an express bus (16% of the low income group participants). Given the previously-identified stated preference for using excess revenues to expand express bus service and to support the addition of park-n-ride lots to support transit, these findings appear to indicate that the public will support expanding express bus service on newly-priced corridors.

Use of Potential Excess Revenues

Although HOT lanes generally do not produce a large amount of excess revenues, above and beyond the costs of operating the system, such facilities can generate excess revenues. Sixteen of the nineteen focus groups were asked whether any excess funds should be restricted to use for projects that are undertaken only on facility from which the funds were generated. Only 34% of the 149 participants that were asked indicated that funds should be restricted to the managed lane corridor, 64% indicated that funds should be used throughout the region, and 2% did not answer.

All 182 of the focus group participants were asked a series of questions regarding what kinds of programs and projects should be supported if excess revenues were generated. Participants were very supportive of a wide-variety of projects in the Atlanta metropolitan area. For example, 79% support using excess toll revenues to make improvements to roads that connect to the tolled facility, 66% were in favor of using these revenues to expand toll lanes to other congested facilities within the region, 74% of participants support using excess toll revenues to repair roads and bridges throughout the region, and 51% of participants support using excess toll revenues to build new roads within the region. However, very few participants indicated that any excess revenues should be used to support projects outside the region. For example, only 6% of the participants indicated that excess revenues should be used to repair bridges and roads elsewhere in the state, only 5% were supportive of building new roads elsewhere in the state, and only 8% were supportive of expanding toll lanes to congested corridors elsewhere in the state.

Only 36% of the participants indicated that excess toll revenues should be used to reduce vehicle registration fees. Surprisingly, a large percentage (67%) of participants indicated that they would like to see revenues used to reduce the statewide gasoline tax. This answer is in contrast with other answers indicating that revenues should remain within the region. In addition, Georgia currently has the lowest state tax levels in the United States. The support for lowering statewide gasoline taxes may have been a reaction to current high gasoline prices. Further investigation is needed to determine whether participants understand what percentage of total gasoline sales price the state gasoline tax represents.

Participants were not very supportive of spending revenues on general programs designed to support carpool formation (31%), but were a bit more supportive of building more park-n-ride lots (52%) for carpools and transit. The support for constructing more park-n-ride lots correlates with stated support for

expanding express bus service along the corridor (47%). However, only 27% of participants support the use of funds to expand MARTA service in the downtown.

Participants overwhelmingly support the use of toll revenues to increase the number of HERO units (81%).

Clean Air Campaign

More than 95% of the 144 participants that were asked have heard of the Clean Air Campaign, which bodes well for the general public outreach campaign undertaken by this organization. Unfortunately, 31% of the participants did not know the answer to the question about whether their employer participated in the Campaign. Of those participants that could answer, 28% knew that their employer did participate, and 35% of the participants knew that their employers did not participate in the Clean Air Campaign (6% did not answer).

Congestion Pricing Response

Section V: Emissions Modeling Assessment Framework



Produced for
Prepared by

**Georgia Department of Transportation
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Congestion Pricing Response

Section V: Emissions Modeling Assessment Framework

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Executive Summary

Transportation planners are required to evaluate the potential air quality impacts of major federal transportation projects. Unfortunately, the complicated processes involve the use of multiple models, making impact analyses difficult and time-consuming to perform for local projects. A single tool designed to automate modeling routines would allow policy makers to more readily modify appropriate model input variables for proposed projects and significantly improve the process of undertaking transportation and air quality conformity analysis in non-attainment areas. These same modeling tools could also be used in project-level air quality impact analysis to evaluate the comparative downwind pollutant concentration impacts of project alternatives for environmental impact assessments. Eventually, automation tools could allow policy analysts to run all required models in background and assess the impacts of a wide variety of infrastructure development on an ongoing basis. The following report provides an overview of the steps undertaken to create such a modeling tool and documents how the model can be used in comparative air quality impact assessments. The modeling toolkit contains three elements that are described in this report: a spatial data element, a MOBILE-Matrix emissions module, and a CALINE-Grid microscale impact assessment module.

The spatial data components of the modeling tool allows users to specify the transportation link coordinates of the network affected by any proposed transportation project or policy as input to the modeling tool. Traffic volume and related data can be integrated from the regional travel demand model (TDM), any traffic simulation model, or from direct observational measurements. The links for the selected roadway system and their associated link IDs can be pulled from the regional travel demand model or from the CORSIM or VisSim simulation models developed for a freeway or arterial corridor. Subfleet composition data and average speed data by facility type are used in the emission rate lookup and composite emission rate development processes of the MOBILE-Matrix element.

The MOBILE-Matrix component of the modeling tool uses a multi-step process to arrive at a composite emission rate for each roadway link and then calculates mass emissions by pollutant for each modeled transportation link. The MOBILE-Matrix modules are based upon previous work performed by members of the research team (Guensler, et al., 2004). The MOBILE-Matrix emission rate elements of the modeling toolkit begin with the creation of a multi-dimensional database of baseline emission rates for the Atlanta region. Thousands of MOBILE6.2 emission rate modeling runs are employed to develop baseline emission rate matrices. Each modeling run incorporates standardized environmental conditions (temperature, humidity, and average barometric pressure) for winter or summer scenarios of interest, along with standardized input parameters to represent regional inspection and maintenance and fuels programs. The resulting MOBILE-Matrix emission rate matrices are organized by calendar year, summer or winter scenario, facility type, onroad vehicle speed, and ambient temperature. Each sub-matrix

contains emission rates by vehicle class and model year. With the multi-dimensional matrix complete, composite roadway emission rates for any calendar year, facility type, onroad vehicle speed, temperature, summer or winter scenario, vehicle class distribution, and model year distribution are developed through a simple mathematical process. Hence, emission rate changes for any project that affects fleet composition or onroad operating conditions can be readily predicted using this modeling tool. Composite emission rates for CO, PM_{2.5}, PM₁₀, NO_x, and HC are multiplied by daily or hourly traffic volumes to predict daily or hourly mass emissions from the facility for mass emissions comparison or emissions budget testing. Coupled with projections of changes in VMT from the travel demand or traffic simulation model, or from direct observation, the net emissions and emissions changes from a facility can be calculated.

Link traffic volumes and composite emission rates are also used as inputs into the CALINE-Grid microscale dispersion element of the model, which allows downwind pollutant concentrations to be automatically generated as part of the modeling process. The CALINE-Grid modeling elements are based upon previous work performed by members of the research team (Guensler, et al., 1999; Guensler, et al., 2000). CALINE4 is a USEPA-approved line source dispersion model developed by the California Department of Transportation (CALTRANS) to predict downwind CO concentrations from highways and arterials (see Benson, 1984, Caltrans, 1988). The CALINE-Grid element of the modeling toolkit automatically performs microscale dispersion modeling throughout the area of a proposed transportation project to predict the worst-case downwind pollutant concentrations associated with the project or to predict downwind concentrations associated with a specific meteorological scenario (for a specific wind direction, wind speed, etc.). The model predicts pollutant concentrations for CO, PM_{2.5}, and PM₁₀, but not for NO_x or HC. A grid of receptors (typically 50 meters x 50 meters) is overlaid on the neighborhood surrounding the project (typically within 1.0 kilometer of the project) to generate a field of predicted worst-case pollutant concentrations or predicted scenario concentrations for a one-hour averaging time. Pollutant concentration isopleths (a topographic-style map of pollutant concentrations in parts per million) and data tables are used to ensure that the project will not lead to the violation of National Ambient Air Quality Standards (NAAQS) and to communicate the severity of pollutant concentrations to decision makers (USEPA, 2007b). For environmental impact assessment work under the National Environmental Policy Act, users can also input receptor locations of interest. Sites where human activity is expected to occur and where hourly pollutant concentrations are to be evaluated (FHWA, 1986) can be added to the receptor grid so that predicted concentrations can be included in EIS documentation.

Throughout this report, the conversion of the carpool lane on the I-85 corridor (from SR 316 to Langford Parkway) to a high-occupancy toll (HOT) lane will be used as the case study demonstrating how the modeling tool can be applied. Although the methodology is reported herein, the analytical results

associated with applying the model to the potential HOT lane implementation will be reported under separate cover.

Introduction

The National Environmental Policy Act (NEPA) requires transportation planners to evaluate the potential air quality impacts of major federal transportation projects. NEPA applies to all major federal projects that have a significant impact on the human environment. Federal projects are those projects involving federal moneys or other resource, projects that require federal approvals (i.e. permits), projects over which federal agencies exert sufficient control to shape the scope of the project, and projects implemented by State agencies on behalf of the federal government (known as federalized projects). The vast majority of transportation projects are considered federal projects. However, for NEPA to apply, such projects also must have a significant impact on the human environment.

When NEPA applies to a project, the NEPA process is designed to identify and disclose significant environmental impacts of proposed projects to decision makers and to the public. NEPA also requires that impacts on various environmental media (air, water, soils, noise, etc.) be presented in a comparative format across alternatives. For major transportation projects, such analyses typically include a detailed air quality impact assessment to determine the downwind pollutant concentrations. Practices for NEPA air quality analyses vary across states, but in general most states follow two guidance documents issued by the Federal Highway Administration (FHWA) in the 1980s. These documents recommend performing detailed microscale impact assessment analysis of projects with potentially significant environmental impacts for presentation in the Environmental Impact Statement (EIS). No comparative alternatives analysis is required for projects classified as Categorical Exclusions or that are determined during the preparation of an Environmental Assessment (EA) to have no significant effect on the environment. However, even when an EA is prepared by the agency in an effort to demonstrate that a project will have a significant environmental impact, and where the agency publishes a Finding of No Significant Impact (FONSI), modeling justification as to why the project does not impact air quality is generally required.

Given the level of effort that goes into the development of a microscale air quality impact assessment, simplified analytical procedures and screening tools are particularly of interest for projects undergoing an Environmental Assessment (EA), where such projects rarely yield a significant impact on air quality. To qualify for a categorical exclusion or for a FONSI based upon preparation of an EA, transportation planners need to apply modeling tools to ensure that the project has no significant air quality impact. Even when significant environmental impacts will occur, and a full Environmental Impact Statement must be prepared, the same modeling tools are typically used to compare the air quality impacts (regional and local) across the transportation project alternatives.

Transportation and air quality conformity regulations derive from the authority of the Clean Air Act and are functionally separate from the NEPA process. Transportation and air quality conformity requirements ensure that transportation and air quality plans proceed using the same assumptions and also require that projects be screened to ensure that they will not cause or contribute to a violation of a National Ambient Air Quality Standard (NAAQS). When a detailed air quality analysis for a single project is required for both conformity and NEPA, it should be coordinated and only performed once (Shaheen, et al., 1995). Transportation conformity refers to the requirements set forth by the Federal Clean Air Act Amendments of 1977 and 1990 and the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, which are designed to ensure that a transportation plan, program, or project is in harmony with the State air quality management plan (AQMP). The process ensures that all of the transportation projects that will be constructed in an urban area, and all of the transportation-related emissions and potential growth-inducing impacts associated with these projects, are specifically accounted for in the AQMP. If a region's 20-year transportation plan and 3-year transportation improvement program are in conformance with the AQMP, and if these transportation plans contain all of the projects that will be constructed in a region, construction of individual projects can be approved from a regional air quality perspective. However, to ensure that none of the local projects cause or contribute to a violation of the NAAQS at the local level, additional microscale analyses are still performed for each project.

The transportation conformity rule requires that a full quantitative project level analysis with complete technical modeling be conducted for Carbon Monoxide (CO) in nonattainment and maintenance areas under specific conditions (40CFR93.123(a)):

- Where the project in question is located in a specific area previously identified in the SIP as an area where a violation is currently occurring or where a violation may occur
- When the project affects an intersection Level-of-Service D, E, or F, or those that will change to Level-of-Service D, E, or F due to increased project-related traffic volumes
- When the project affects any of the top three intersections by traffic volume in the nonattainment or maintenance area
- When the project affects any of the three intersections with the worst level volume in the nonattainment or maintenance area

The transportation conformity rule also requires that a quantitative analysis be completed for PM_{2.5} and PM₁₀, but this rule will not go into effect for PM_{2.5} and PM₁₀ until the EPA issues modeling guidance. As of June 2008, such quantitative guidance has not been issued. The most recent guidance issued in March 2006, includes only qualitative guidelines for PM_{2.5} and PM₁₀ hot spot analysis (USEPA, 2006). When quantitative guidance is issued and the rule goes into effect, PM analysis will be required under the following conditions (40CFR93.123(b)):

- New or expanded highway projects that have a significant number of or significant increases in diesel vehicles
- When the project affects an intersection Level-of-Service D, E, or F with a significant number of diesel vehicles, or those that will change to Level-of-Service D, E, or F due to increased project-related traffic volumes from a significant number of diesel vehicles related to the project
- New bus and rail terminals and transfer points that have a significant number of diesel vehicles congregating at a single location, and expansions of such facilities that increase the number of diesel vehicles
- Where the project in question is located in a specific area previously identified in the SIP as an area where a violation is currently occurring or where a violation may occur

MOBILE emission rates for PM_{2.5} are generally slightly higher (around 2% higher) for summer modeling months, based upon Atlanta typical scenario temperatures. According to EPA's Technical Guidance (USEPA, 2004) users estimating annual particulate matter emissions are advised to develop emissions rates for January and July, interpolate emission rates for the other ten months of the year, and then sum monthly estimates to obtain annual emissions. When new PM guidance is adopted by the USEPA, it will likely be necessary to undertake a subsequent review of final regulations and EPA guidance documents before using the MOBILE-Matrix modeling tool for developing particulate matter inventories.

Detailed microscale analyses must employ the use of federally-approved air quality impact assessment models (such as CALINE4 or CAL3QHC), unless a regional transportation conformity working group provides for an exception to this requirement by approving alternative modeling tools for such analyses. For other projects that do not fall into the categories mentioned above, the conformity regulations provide for the use of less quantitative analytical procedures that "represent reasonable and common professional practice," such as lookup tables and screening techniques. Even qualitative methods that consider local factors, such as comparing the project parameters to those of previous projects that have been analyzed in detail and deemed not to impact air quality, can be employed provided that the conformity working group approves such alternative analytical techniques in advance. A survey of such screening procedures can be found in Houk and Claggett (2004).

Transportation investments and policy changes, such as constructing a new major arterial or implementing high-occupancy toll (HOT) lanes, can have a variety of impacts on factors that affect roadway emissions and therefore local and regional air quality. The MOBILE-Matrix CALINE-Grid modeling approach described in this report is currently being applied by Georgia Institute of Technology (Georgia Tech) researchers to assess the potential project emissions and microscale pollutant impacts of converting the existing HOV facility on the I-85 corridor north of Atlanta into a HOT lane. If such a

conversion were to take place, a number of traffic volume and operating conditions changes are expected to result. Because the current HOV lane operates under congested conditions, lane speeds are expected to increase during the peak period once HOT pricing is implemented (changing the emission rates). Traffic volumes are expected to increase on the HOT lane because uncongested lanes carry more vehicles per hour than do congested lanes. Because a HOT lane carries more vehicles than its HOV predecessor, congestion relief and increased speeds are also expected on the general purpose lanes. Finally, because the user demographics are different for HOT lane operation and HOV lane operation, and vehicle age is linked to user demographics, the model year distribution of vehicles using the HOT lane is also expected to change. The MOBILE-Matrix system allows for all of these variables to be changed simultaneously, so that the combined effect of subfleet composition, operating speeds, and traffic volumes can be modeled with one pass through the modeling system. The modeling tool supports testing of hypotheses associated with policies that would affect the emissions predictions inform changes in:

- Onroad vehicle class distributions (e.g. light-duty automobiles and light-duty trucks)
- Onroad vehicle age distributions (model year)
- Annual mileage accumulation rates by model year
- Average onroad operating speeds (speed/acceleration profiles)

Even when policy makers understand how a project/policy change might affect these emission-related parameters, it is often difficult to translate the effects into air quality impacts due to the lack of a single user-friendly modeling system. The U.S. Environmental Protection Agency's (USEPA's) MOBILE6.2 model provides emission rates for various scenarios, and modelers must provide complete input files for each scenario and compile emission rate results. The MOBILE6.2 emission rate outputs must then be input into a dispersion model, such as CALINE4, along with traffic volumes and meteorological variables to predict the effects on ambient air quality. Unfortunately, given the complicated process, impact analyses are difficult and time-consuming to perform for local projects. The modeling tools presented in this report constitute a modeling system to automate this process. Policy makers can modify appropriate model input variables to reflect conditions associated with proposed policies or individual projects and the tool automatically runs all required models in background. The modeling approach can significantly improve the process of undertaking project level air quality analysis as well as conformity analysis in non-attainment areas. These same modeling tools would then also be amenable for use in evaluating the comparative impacts of project alternatives in environmental impact assessment documents.

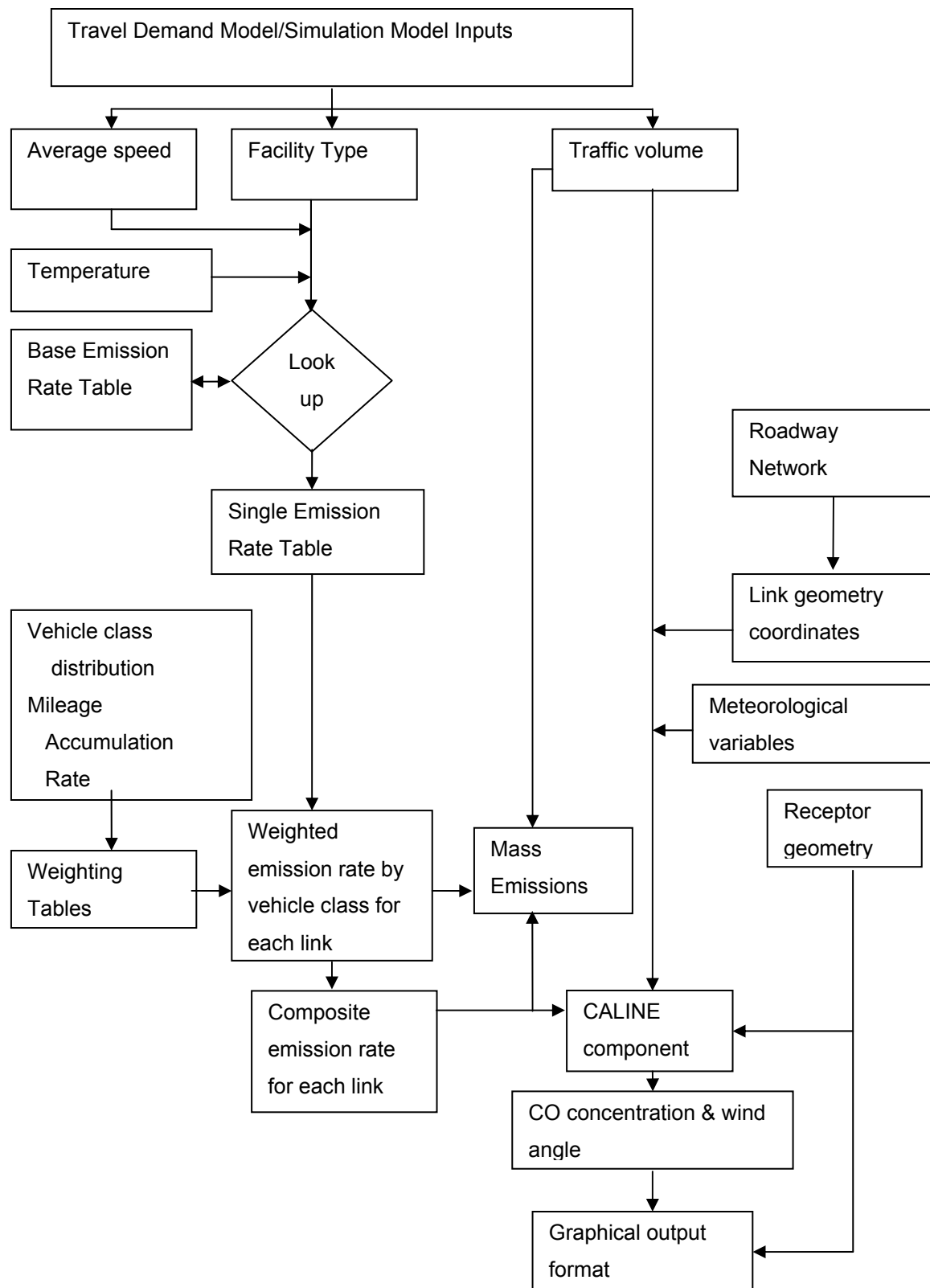
Overview of the MOBILE-Matrix/CALINE-Grid Modeling Tool

The modeling system includes two major sub-modeling systems, a MOBILE6.2 element that employs large emission rate lookup matrices, known as MOBILE-Matrix, and a CALINE4 microscale dispersion modeling element designed to predict gridded pollutant concentration levels associated with the transportation system, known as CALINE-Grid. The MOBILE-Matrix portion of the tool calculates emission rates for CO, PM_{2.5}, PM₁₀, and the ozone precursors NO_x and HC, while the CALINE-Grid portion of the tool calculates the emissions dispersion concentrations only for CO, PM_{2.5}, and PM₁₀.

The modeling toolkit begins with the creation of a multi-dimensional database of baseline emission rates for the particular region of interest, organized by calendar year, summer or winter scenario, facility type, onroad vehicle speed, ambient temperature, vehicle class, and model year. Thousands of MOBILE6.2 modeling runs are required to develop baseline emission rate matrix. With the multi-dimensional matrix complete, composite roadway emission rates can be calculated for any link in the transportation system through a relatively simple mathematical process. Hence, any increase in emission rates associated with the proposed implementation of a project that changes the fleet composition or onroad operating conditions (which would be expected to result from congestion pricing projects) can be readily predicted using this tool. Coupled with projections of vehicle miles of travel (VMT), the system estimates mass emissions of CO, PM_{2.5}, PM₁₀, NO_x, or HC from each facility.

The CALINE-Grid element of the modeling toolkit automatically performs microscale dispersion modeling throughout the area of the proposed transportation project to predict the worst-case downwind pollutant concentrations associated with the project for use in planning analysis. Similarly, the modeling tool can be used to assess downwind pollutant concentrations for specific meteorological conditions (wind direction, wind speed, etc.) for use in scenario analysis. Pollutant concentrations are calculated for CO, PM_{2.5}, or PM₁₀, but not for NO_x or HC (as these are considered regional pollutants that contribute to ozone formation). A 50 meter by 50 meter grid of receptors is overlaid on the neighborhood surrounding the project (typically within 1.0 kilometer of the project) to generate a spatial field of worst-case pollutant concentrations for one-hour averaging time (or predicted concentrations for a specific wind scenario). The concentration isopleth diagram (a topographic-style map of pollutant concentrations expressed in parts per million) can be evaluated to ensure that the project will not lead to a violation of NAAQS. The modeling tool also provides the flexibility of adding specific receptors of interest for locations where human activity is expected to occur (FHWA, 1986). These can be added to the receptor grid so that predicted concentrations can be included in EIS documentation. Figure 1 shows a flowchart summarizing the MOBILE-Matrix and CALINE-Grid methodology.

Figure 1: MOBILE-Matrix and CALINE-Grid Methodology Flowchart

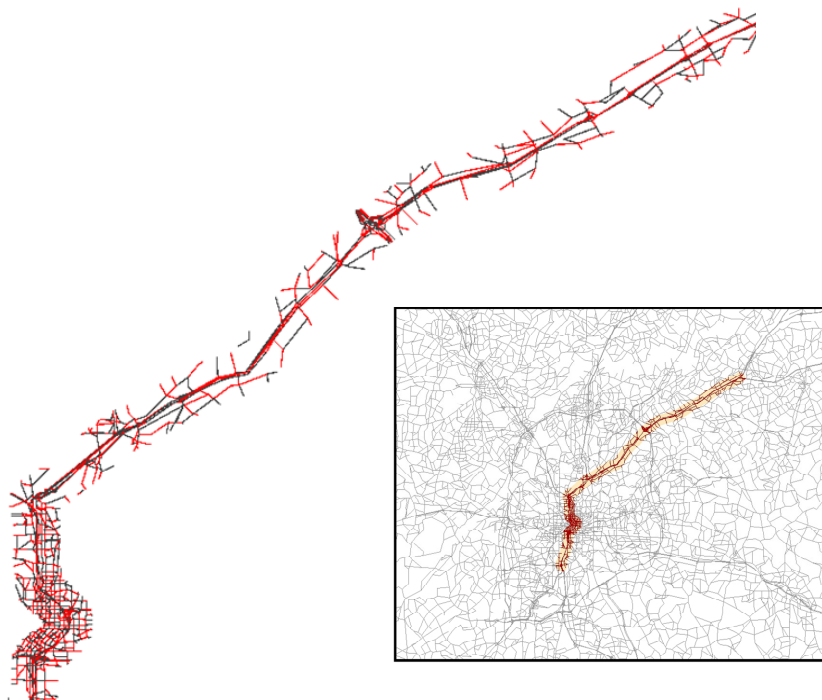


The remainder of this report describes the theory behind how each of these components work. A preliminary description of the travel demand modeling and simulation frameworks (for selection of networks to be analyzed and traffic volumes) is provided first, followed by descriptions of the MOBILE-Matrix and CALINE-Grid subroutines. This modeling system will be useful in carrying out project level air quality analysis for the Atlanta region. Throughout this report, the conversion of the carpool lane on the I-85 corridor (from SR 316 to Langford Parkway) to a high-occupancy toll (HOT) lane will be used as the case study demonstrating how the modeling tool can be applied.

Transportation Network Selection

The spatial layout of the roadway network that will be affected by a proposed transportation project or policy is the first model input provided by the user. For example, onroad operating speeds are integral to the emission rate lookup process of the MOBILE-Matrix element, and link traffic volumes are used in mass emission calculations for each link and serve as inputs into the CALINE-Grid microscale dispersion element. Figure 2 below shows an example of selecting the roadway network located within 0.5 miles of I-85 from State Route 316 to Langford Parkway in Atlanta, GA, for use in an evaluation of proposed high-occupancy toll (HOT) lanes on this route. The links for this roadway system and their associated link IDs can be pulled from the Atlanta regional travel demand model or from a transportation simulation model (e.g. CORSIM or VisSim) developed for the freeway corridor. The link IDs are processed into the modeling tool via the user interface, as will be discussed later.

Figure 2: Roadway Network within 0.5 miles of a Proposed I-85 HOT Corridor



MOBILE-Matrix Element

Each vehicle on a roadway produces emissions at different rates, depending on characteristics such as vehicle class, vehicle age, ambient temperature, operating speed by facility type, etc. The MOBILE-Matrix element incorporates these characteristics in the creation of composite emission rates (grams/vehicle-mile) for each link in the roadway network. The emission rates are multiplied by hourly vehicle miles of travel to predict hourly emissions from the facility for emissions budget tests. These emission rates also serve as an input to the CALINE-Grid air dispersion model component. The following sections details each step in this process.

Standard Emission Rate Lookup Matrix

The MOBILE-Matrix element uses a multi-dimensional lookup matrix containing region-specific emission rates (in grams/mile) for vehicle class, vehicle age, calendar year, evaluation month, facility type, speed, temperature, and humidity. For the Atlanta region, a standard input file provided by the Atlanta Regional Commission (ARC) is used as an input to the iterative MOBILE6.2 modeling run process used to generate summer ozone period emission rate matrices. A similar file is used for wintertime carbon monoxide analyses, but with a specific worst-case temperature and applicable winter fuels parameters.

Separate input files are created for carbon monoxide (CO), hydrocarbons (HC), oxides of nitrogen (NO_x) and particulate matter (PM_{2.5} and PM₁₀). In an iterative fashion, successive alterations are made to the input file for each iterative MOBILE6.2 modeling run to create output emission rate data that can be compiled into a multi-dimensional emission rate lookup matrix. For example, the input file is run through all combinations of average speeds from 2.5 to 65 mph, in increments of 5 mph, and temperatures from 20 degree to 105 degree Fahrenheit, in 5 degree increments. Iterative runs are employed so that standard emission rate outputs can be created for each of the following characteristics:

- 2 seasons: summer and winter¹
- Calendar year (year of evaluation) 2007 to 2030
- 3 facility types: highway, arterial, and ramp
- 14 speed bins: 2.5 mph and 5-65 mph in 5 mph increments
- 18 Temperatures: 20 degree to 105 degree Fahrenheit in 5 degree increments.
- 2 set of 24 hour humidity values for summer and winter.
- 28 vehicle classes: Light Duty Gasoline Vehicle (LDGV), Light Duty Gasoline Truck 1 (LDGT1), etc. (USEPA, 2003a)

¹ The model currently employs only the emission rate matrices for summer ozone planning. A separate winter run will be used to prepare matrices for use in Winter CO analyses (to account for winter fuel composition). The team plans to integrate this element into the model during Summer 2008.

- 25 model years: the current model year and 24 previous model years (with the last group representing all older vehicles)

Examples of the MOBILE6 input files are provided in Appendices A through D. The current version of the tool outputs CO, HC, NO_x, PM_{2.5}, and PM₁₀ exhaust emission rates.

The MOBILE-Matrix tool computes emission rates for both summer and winter conditions for use in the lookup tables. Different humidity values must be used for summer and winter to account for different worst-case scenarios for different pollutants. For example, ozone is the primary pollutant of concern in the summertime. Sensitivity analyses show that NO_x and HC emissions, which are ozone precursors, are affected by humidity levels. Therefore, the Atlanta Regional Commission (ARC) uses average humidity values from the 10 days with the highest ozone levels from 1988-1990 for one-hour ozone standard analysis and from the 10 days with the highest ozone levels from 2000-2002 for 8-hour ozone standard analysis. These hourly relative humidity values, which are obtained from the National Weather Service Local Climatological Data, are used for the ARC's ozone standard regional emissions analysis, as well as for developing Atlanta's MOBILE-Matrix emission rates.

In the winter, the primary pollutants of concern are carbon monoxide (CO) and particulate matter (PM). However, since sensitivity analyses show that MOBILE6 CO and PM_{2.5} emission rates do not incorporate humidity effects, average humidity levels from all days in January over three years from 2000-2002 are used in the MOBILE-Matrix tool. These data are commonly used by the Georgia Department of Natural Resources and were obtained from National Weather Service Local Climatological Data for Hartsfield Jackson International Airport in Atlanta.

Both of these alternative sources for relative humidity values utilize local Atlanta data. Twenty-four relative humidity values are used in the MOBILE input, one for each hour of the day. Table 1 lists the humidity values used in the MOBILE-Matrix tool for summer and winter.

It should be noted that national defaults are used for mileage accumulation when creating the standard emission rate lookup tables. However, it is conceivable that under certain policy scenarios, annual mileage accumulation rate might change within the fleet, or for a subset of the fleet. When a user alters the mileage accumulation rates (as demonstrated in the weighting tables section below) emission rates are affected because MOBILE6.2 actually accounts for the deterioration effects of greater mileage accumulation on the vehicle emissions. In other words, MOBILE6.2 assigns higher emission rates to a particular model year vehicle with higher annual mileage accumulation than it does to a particular model year vehicle with lower mileage accumulation. This effect can be observed in Figure 3, which shows an example of how emission rates vary for light-duty vehicles (passenger cars) in the calendar year 2020

when mileage accumulation is doubled and all other variables are held constant. It should be noted that emission rates vary across vehicle types when mileage accumulation rates double. For some heavy duty diesel vehicles, emission rates are not affected by mileage accumulation (e.g. ages from 0-13), but they do vary with mileage accumulation for vehicles age 14 and older, as shown in Figure 4 for HDDV8A trucks.

Table 1: Humidity Values used in MOBILE-Matrix Tool

Time of Day	Relative Humidity (%)	
	Winter	Summer
6:00 AM	80	68
7:00 AM	81	68
8:00 AM	77	68
9:00 AM	73	50
10:00 AM	66	50
11:00 AM	61	50
12:00 PM	56	37
1:00 PM	54	37
2:00 PM	51	37
3:00 PM	51	32
4:00 PM	52	32
5:00 PM	56	32
6:00 PM	60	40
7:00 PM	63	40
8:00 PM	65	40
9:00 PM	68	56
10:00 PM	70	56
11:00 PM	72	56
12:00 AM	73	64
1:00 AM	75	64
2:00 AM	76	64
3:00 AM	77	70
4:00 AM	78	70
5:00 AM	79	70

Figure 3: Effect of Doubling of Mileage Accumulation Rates on LDV CO Emission Rates

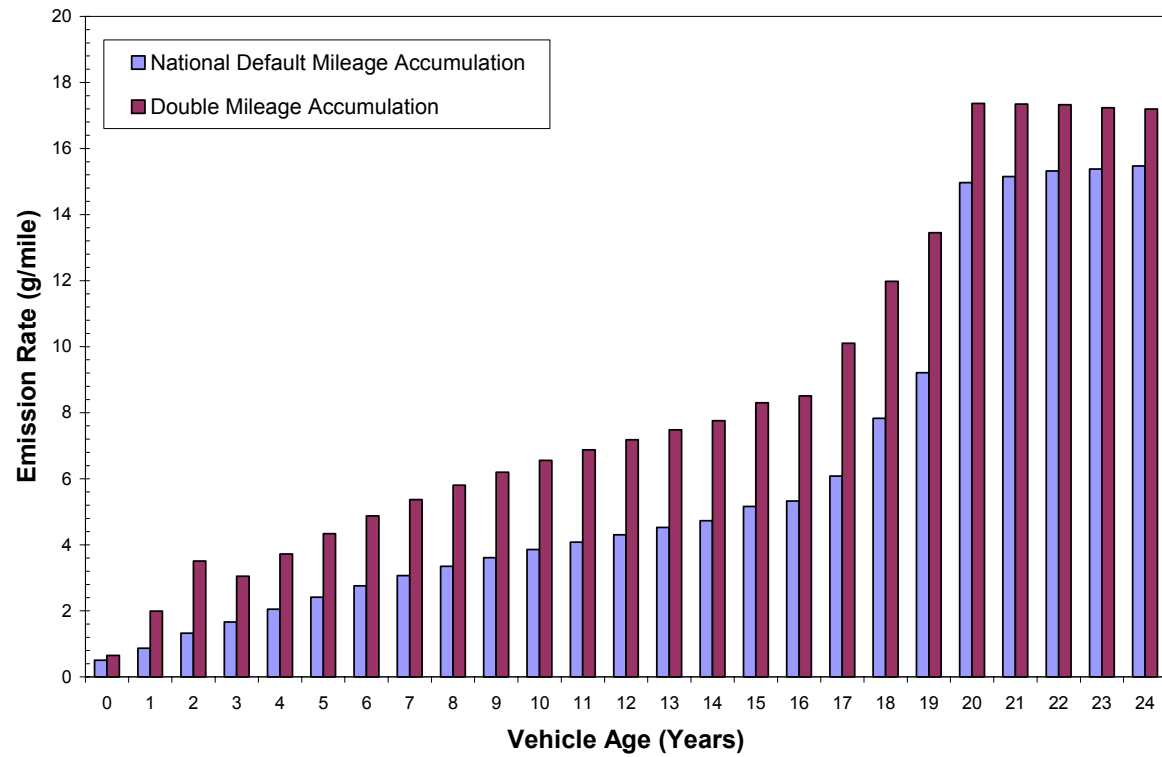
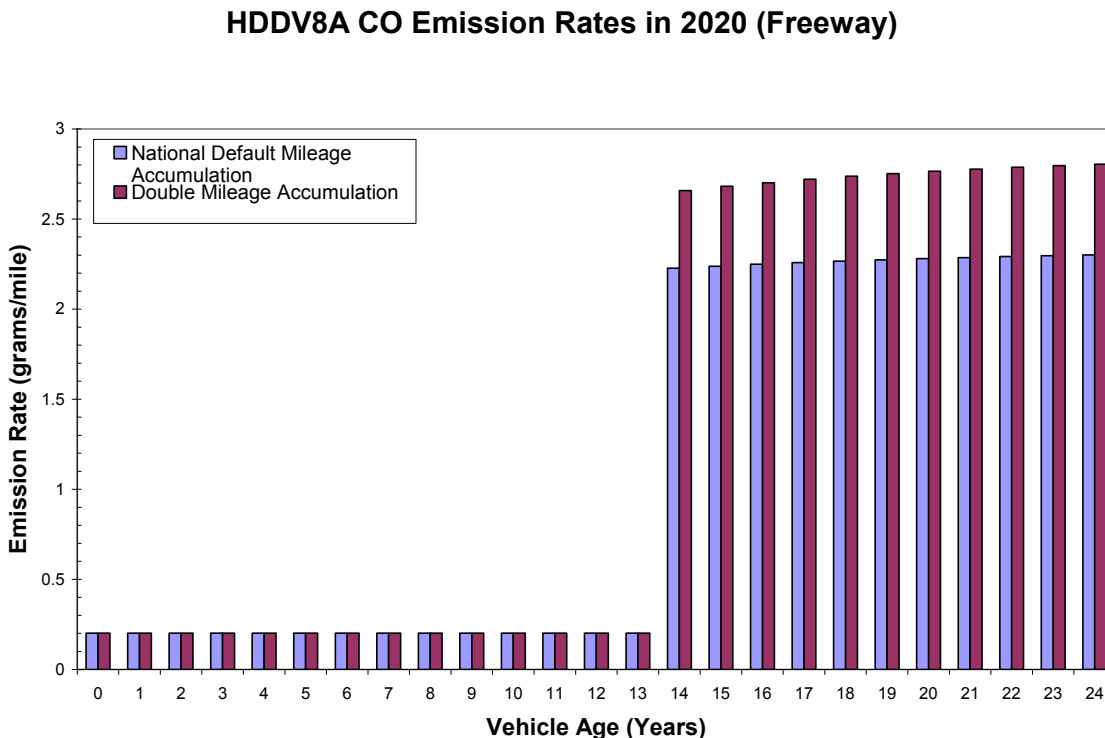


Figure 4: Effect of Doubling Mileage Accumulation Rates on HDDV8A CO Emission Rates



These deterioration effects become problematic when attempting to use standard outputs from MOBILE6.2. Because the MOBILE-Matrix tool only uses emission rates from a set of standard MOBILE runs that do not vary mileage accumulation rates, the standard outputs will omit the effect of the resulting change in deterioration rates. Instead, the lookup tables only provide emission rates associated with national defaults for mileage accumulation, which were provided as inputs to the standard MOBILE runs that are all completed before deployment of the tool. To allow the user of the tool to alter mileage accumulation to a value other than national defaults, it is necessary to either dynamically run MOBILE with each run of the tool, or use a correction factor. To maintain the original MOBILE-Matrix design, which has several advantages by running MOBILE6.2 before deployment, it is necessary to use an emission rate correction factor to account for the impact of increased mileage accumulation rates on the different MOBILE6.2 deterioration rates.

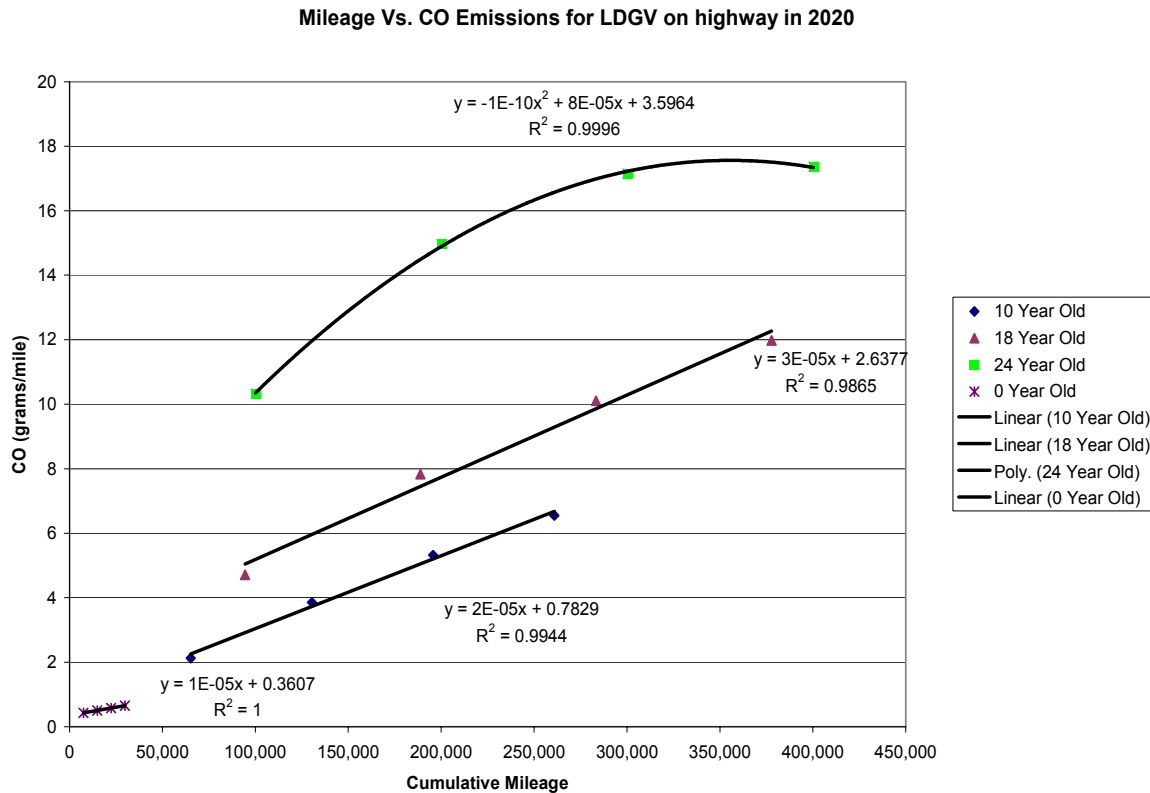
This correction factor is calculated through regression equations designed to represent the relationship between emission rates and mileage accumulation for a vehicle of a specific age and class. To create these equations, a collection of model output data points are needed for analysis. Emission rates were obtained from MOBILE6.2 for 0.5, 1, 1.5, 2, and 2.5 times the national default mileage accumulations for all vehicle classes and ages. For the runs with 2.0 and 2.5 times the national default mileage accumulations, MOBILE6.2 issues a warning message stating, “Normal and high average emission rates

are the same. All vehicles have been treated as normal emitters.” The emission rates for these two runs are exactly the same, so the run for 2.5 times the defaults was dropped from the next steps of the analysis.

The emission rates are graphed for light duty gasoline vehicles as an example, and Figure 5 illustrates how the four points are used for each vehicle age and class to form a regression equation approximating the relationship between mileage accumulation and emission rates. For LDGV CO emissions, ages 0-19 exhibit a linear relationship, while older ages exhibit a polynomial relationship. A table of these equations is easily created in a spreadsheet and an r-square value can also be calculated to verify that a particular equation type fits the data well. Different equations (linear vs. polynomial) were used for LDGV to provide an r-square value greater than 0.9 in all cases. The relationships may vary when performing the same analysis for other vehicle classes and pollutants, so it is necessary to customize the analysis for each situation to get the best-fitting regression equations. Separate regression equations are created for each pollutant, vehicle class, and vehicle age being considered. For the MOBILE-Matrix tool there are 5 pollutants (CO, HC, NO_x, PM_{2.5}, and PM₁₀), 28 vehicle classes, and 25 vehicle ages yielding 3,500 regression equations (and a matrix of beta coefficients for use in internal calculations).

The final step to create the correction factor for integration into the MOBILE-Matrix tool is to apply the user-supplied mileage accumulations to the regression equations. This provides the predicted emission rate for the new mileage accumulation. The predicted emission rate is then divided by the corresponding emission rate for a default mileage accumulation to provide the correction factor. This correction factor is multiplied by the base emission rate in the lookup tables to adjust for mileage accumulation change impacts on deterioration rates. The corrections are handled internally before emission rates are weighted and summed by vehicle class and age.

Figure 5: Example regression equations for LDGV



Link-Based Emission Rates

Applicable 28 x 25 emission rate sub-matrices are selected for each link based upon facility type, year and month of evaluation, ambient temperature and humidity. The selected matrices represent the set of applicable average speeds in 5 mph increments. Information about the link facility type and average speed are required in the link file input table. The user can obtain these values from a travel demand model (TDM) or simulation model. The case study for this tool uses traffic volume and average speed data from the ARC's travel demand model. As the ARC model provides a single speed value (e.g. 17 mph), the current version of the tool uses a harmonic mean to estimate the contribution from the closest two 5 mph matrices (USEPA, 2003b).

In cases where the user does not have a distribution of speed data to use as a model input, a new procedure has been proposed for development by Georgia Tech to distribute single average speed estimates for a link (by roadway class) across the 14 speed bins. This would allow a single average speed value taken from a travel demand model to be distributed among the 14 MOBILE6.2 speed bins, providing a weighting value for the emission rate contribution from each 5mph average speed matrix. That is, if 15% of the vehicles on a specific roadway classification are moving at 45 mph when the

average speed is 55 mph, 15% of the weighted emission rate contribution for these vehicles is taken from the matrix for 45mph. A single 28 x 25 composite emission rate sub-matrix that accounts for onroad operating speeds is formed through this process. Users that already have adequate binned speed data can associate a speed bin file with each roadway type or roadway segment and override the automatic input of speed from the travel demand or simulation model.

All facility types except for local roads are included in the tool. Local roads are excluded since their impact on project-level emissions is generally negligible. Exclusion of local roads substantially reduces the computer processing requirements of the tool. Specific local roads can be added into the system manually when their effect is known to be significant, such as local roads serving truck stops or freight facilities where significant heavy-duty vehicle activity is noted.

Weighting Tables for Vehicle Subfleet Characteristics

Because the emissions from each vehicle on a roadway are a function of the vehicle class and model year, an essential part of the emissions modeling process is determining the relative percentages of vehicle class model year combinations that are operating on each road. Almost every region specifically accounts for differences in vehicle classes on roadways (e.g., different truck percentages are assigned to different facility types and even to different routes). In this way, if 15% of the traffic on a roadway is from heavy-duty trucks, 15% of the composite emission rate contribution will be taken from truck emission rates. Older vehicles emit much more pollution per mile than newer vehicles. So, once the fleet is divided into vehicle classes, it is necessary to incorporate the percentage of vehicles by model year to estimate the vehicle-class-specific emission rate. Modelers might use a registration database to estimate onroad model year distributions; however, according to the EPA's national default mileage accumulation rates, newer model year vehicles are driven many more miles each year than older vehicles (USEPA, 2001). In essence, the probability of seeing a specific model year vehicle on the roadway is a function of how many are in the region and how many miles they drive relative to the other vehicles in the fleet. To account for this, most regions, including the Atlanta metropolitan area, weight the registration database model year mix by the annual mileage accumulation rate for each model year. The ARC uses national default mileage accumulation rates for this, and therefore these are the default values used in the tool. However, other regions often use local data taken from their smog check database (where odometer readings are collected every year). Therefore, the tool also has the capability of accepting user-supplied mileage accumulation rates, as described below.

Figure 6 illustrates the user-supplied data that can be provided in the form of input tables for: a) onroad vehicle class distribution, b) vehicle age distributions by model year and vehicle class, and, c) annual mileage accumulation rates by model year and vehicle class. As outlined above, the information in these

matrices can be employed to estimate the onroad fleet composition and mileage contribution for any link by vehicle class and model year.

These tables are initially populated using national default data. However, the user can opt to replace some or all of the values and leave default data where no local data are available. In the MOBILE-Matrix process, when users have more representative or reliable data than the defaults, the users should use such data. For example, information for parameters for onroad vehicle class distribution, vehicle age distributions by model year and vehicle class, and annual mileage accumulation rates by model year and vehicle class (Figures 6(b) through 6(c)) can be input by the user using regional data such as the Atlanta Regional Commission (ARC) default values. The ARC uses data from Polk and Associates, previously analyzed by the Georgia Environmental Protection Division (EPD), to create local registration distribution fractions, but they still assume national defaults for mileage accumulation and VMT fractions. Local registration databases are usually better than national defaults, smog check data are usually better than defaults for annual mileage accrual rates, and observation of vehicle class counts on different facilities by time of day provide much better estimates of actual onroad fleet composition than any modeled estimates. Finally, the user also has the option to directly enter observed onroad vehicle age distributions, which might come from onroad license plate studies directly into a table (Figure 6(d)), which would override the matrix calculated from data in the other tables (Figures 6(b) through 6(c)). Noted differences between the onroad fleet composition observed on a roadway facility and the presumed fleet composition derived from registration data and mileage accumulation rates is significant and has a large impact on predicted link-based emissions (Granell, 2002). For example, Granell (2002) determined that older vehicles are used more in areas where low income residents live and work and are used more on local roads than on freeways. On the average, such variations across localities cancel out over the region, providing an accurate region-wide inventory of mass emissions. But the errors at the local level mean that inaccurate composite emissions rate may be used for any specific freeway or arterial. MOBILE6.2 does not include a function allowing users to enter the actual observed onroad subfleet composition. This flexibility, which is built into MOBILE-Matrix, is a key advantage of the new modeling system over using MOBILE 6.2 directly.

The first step in the internal calculation process to obtain link-specific fleet composition is to employ the data contained in the tables illustrated in Figures 6(b) and (c). The vehicle age distribution is normalized by the mileage accumulation rates for these model years to create a class-specific weighting fraction that will be used in the subsequent calculation of composite emission rate (Equation 1). As indicated earlier, if the user supplies direct observations, these results of these calculations are ignored.

$$WF = \frac{(MAR * VAD)_{VC}}{\sum_{i=1}^{25} (MAR * VAD)_{VC}} \quad (1)$$

Where,

WF is the weighting fraction

MAR is the annual mileage accumulation rate

VAD is the contribution to vehicle age distribution

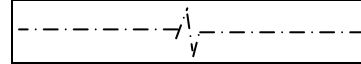
VC is the vehicle class from 1 to 28

i is the vehicle age from 1 to 25 (years)

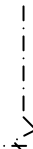
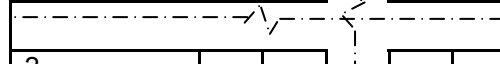
Figure 6: Format of the Input Tables used to Develop Onroad Weighting Fractions

(a) VCD = Vehicle Class

Distribution (onroad fraction for each class)

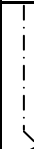
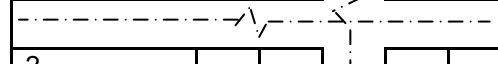
Vehicle Classification	VMT Fractions
LDGV	
LDGT1	
	
HDDBS	
LDDT34	

(b) VAD: Vehicle Age Distribution by (fraction for each MY by class)

			Fraction of Vehicles by MY in each class		
Vehicle Age (Years)	LDGV	LDGT1		HDDBS	LDLT34
25					
24					
23					
					
2					
1					


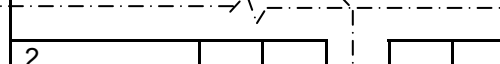
(c) MAR - Mileage Accumulation Rate

(annual miles/year by vehicle class)

			Miles per year by Vehicle Class		
Vehicle Age (Years)	LDGV	LDGT1		HDDBS	LDDT34
25					
24					
23					
					
2					
1					

(d) Onroad Subfleet Composition

(onroad fraction by MY for each class)

			Onroad Subfleet Composition		
Vehicle Age (Years)	LDGV	LDGT1		HDDBS	LDDT34
25					
24					
23					
					
2					
1					

Calculation of Composite Emission Rates

A composite emission rate for each link is calculated by cross-multiplying the baseline emission rate sub-matrix with the weighting table from the third step. The matching cells in each table are identified and multiplied, and the cell products are summed across vehicle ages to calculate aggregated emission rate by vehicle class for each link. These aggregated emission rates are then weighted by the VMT fractions and summed across the vehicle classes to yield a fleet average composite emission rate (Equation 2) for that link.

$$CER = \sum_{j=1}^{28} [VCD * \sum_{i=1}^{25} (WF * BER)] \quad (2)$$

Where,

CER is the composite emission rate (gram/mile)

VCD is the contribution to Vehicle Class Distribution (VMT fractions) for each vehicle class

WF is the weighting fraction developed in Equation 1

BER is the base emission rate (gram/mile)

i is the vehicle age from 1 to 25 (years)

j is the vehicle class from 1 to 28

This gram/mile emission rate value is multiplied by vehicle activity (vehicle-miles) on the roadway to generate the mass emissions estimate. The emission rate is also provided as an input into the CALINE4 model in the next component of modeling tool.

Calculation of Mass Emissions by Link

The MOBILE-Matrix process provides composite emissions rate for use in the CALINE4 model, but the same outputs can be used to quantify the mass emissions from each roadway link for use in emissions inventory development, conformity analyses, or emissions budget tests. Traffic volumes (vehicles/hour) passing along each roadway (e.g. between two exits on a freeway) are taken from a travel demand or simulation model and coupled with link distance (miles) to provide an estimate of vehicle miles of travel every hour. The hourly vehicle miles of travel estimates are multiplied by the link-specific composite emissions rates (grams/vehicle-mile) to generate hourly mass emissions outputs for each link. Alternatively, calculations could be performed for each vehicle class and model year if additional resolution is desired.

CALINE-Grid Modeling Component

Air quality impact assessment modeling may involve hundreds of roadway links and receptors of interest for a major transportation project. The CALINE-Grid element of the modeling framework employs an iterative process involving thousands of model runs to summarize the cumulative impacts of all links on each receptor of interest under specified meteorological conditions. The CALINE-Grid component begins with the creation of a baseline CALINE4 microscale dispersion model input file. The CALINE4 base input file contains the applicable worst-case meteorological data (winter day temperature, wind speed, mixing height, stability class, etc.) and other standard input parameters. For each model iteration, specific link parameters (coordinates, traffic volumes, vehicle speeds, and composite emission rates) and receptor locations are integrated into the standard input file. Computer scripts coded with the PERL programming language capture the iterative outputs, process and summarize the predicted pollutant concentration impacts of every roadway link on every receptor, and transfer resulting pollutant concentrations to a script for creation of supporting maps and documentation.

The traffic volumes and emission rates developed in the MOBILE-Matrix element are employed in the CALINE-Grid microscale dispersion modeling element. A computer script coded in PERL programming language feeds the outputs of vehicle activity from the travel demand model and emission rates from the MOBILE-Matrix element into the CALINE4 dispersion model used in the CALINE-Grid process. Various parameters such as link geometry, meteorological variables, receptor geometry, aerodynamic surface roughness coefficient, and background CO concentrations are entered as inputs to the dispersion model base file. Another program calls CALINE4 in an iterative process, integrates the vehicle activity parameters and emission rates, and runs the CALINE analysis for all combinations of roadway links and receptor sites. This process is repeated as many times as necessary to assess the impact of each link on each receptor, with the results being summed to predict worst-case CO, PM_{2.5} and PM₁₀ concentrations. In worst-case mode, the model predicts and displays the pollutant concentration and worst-case wind angle for each receptor in the region. A standardized graphical output is prepared depicting the worst-case CO, PM_{2.5}, and PM₁₀ conditions using color-coded pollutant concentration isopleths and the wind angles at each receptor location corresponding to these concentrations portrayed as a vectors.

Microscale Dispersion Modeling

Air quality impacts are generally addressed using one of the three possible scales of analysis: microscale, mesoscale, or regional scale. The dynamics of transport and photochemical transformation of the pollutant usually dictates the scale of air quality impact analysis. For example, ozone is formed in the atmosphere due to a complex chain of reactions between sunlight, nitrogen dioxide and hydrocarbons. Microscale analyses are usually conducted immediately downwind of a facility (say within 500m) and pollutants are often modeled as being non-reactive. A mesoscale air quality impact assessment often

covers the size of a metropolitan area or urban airshed and accounts for pollutant interactions at multiple levels. However, acid rain can be analyzed only by considering a macro-scale region, encompassing multiple states or nations. The impact of transportation systems on regional air quality (e.g. 8-hour ozone concentrations and annual particulate matter concentrations) is usually handled at the mesoscale level. The impact of individual transportation facilities on local air quality (e.g. 1-hour and 8-hour carbon monoxide levels) is usually modeled at the microscale level.

Carbon monoxide and fine particulate matter are considered to be the foremost microscale problems. CO is a relatively inert gas formed by the incomplete combustion of fossil fuels and concentrations generally peak during the winter months near transportation facilities having high vehicle volumes and low speeds. Particulate matter is composed of solid or liquid particles varying in size and physicochemical properties. The particles having an aerodynamic diameter less than or equal to 10 micrometers are categorized as PM₁₀, while those having an aerodynamic diameter less than or equal to 2.5 micrometers are categorized as PM_{2.5}. Low temperatures during winter hamper the pollutant dispersion, thus elevating CO, PM_{2.5}, and PM₁₀ concentrations. Microscale dispersion modeling is carried out using CALINE4 or CAL3QHC to identify potential violations of the national ambient air quality standards due to the implementation of any highway related project that might increase emissions. The CALINE model is employed in the modeling tool because the code and modeling procedures could be readily adapted into the system.

The entire process of microscale dispersion modeling is divided into following sections:

- Input data collection.
- Prediction of worst-case pollutant concentration.
- Comparison of predicted concentration with NAAQS

CALINE Input Data

Various geographical, meteorological, traffic, and emissions related inputs are needed to run the CALINE4 dispersion model. The geographical inputs include the roadway link and receptor coordinates. Meteorological inputs comprise parameters such as wind speed, wind direction, wind direction variability, ambient temperature etc. Traffic inputs include traffic volumes for each link from the travel demand model. The weighted composite emission rates for each link are taken from the Mobile-Matrix model component as inputs to the dispersion modeling process.

Roadway Link Geometry

The first step in the modeling process is to prepare a spatial representation of the area affected by the proposed transportation project. Potential roadway links are identified on the spatial network within the travel demand model or simulation model. The spatial data employed in transportation modeling provided by the Atlanta Regional Commission (ARC) can serve as the basis for the spatial analytical work in

Atlanta. However, standard roadway parameter files from any simulation model can also be applied. In the case study along the I-85 corridor, all roadway links within half a mile of the Interstate from Georgia 316 to the north and Langford Parkway to the south were extracted from the spatial dataset (Figure 2). The link input dataset consists of the X, Y coordinates for the start and end nodes of each modeled link. The traffic volume and vehicle speed information can be referenced from ARC's Travel Demand Model (TDM) or from an external simulation model.

Traffic Volumes

Link traffic volumes can be developed by running the 4-Step Travel Demand Model (for example, in the Atlanta case study the traffic volumes are provided by the Atlanta Regional Commission travel demand model). Alternatively, link volumes can be pulled from the output files of traffic simulation models, such as VISSIM or CORSIM.

Meteorological Variables

The meteorological data used as input to the CALINE-Grid element represent either the summer ozone planning regime or winter planning scenarios designed to predict worst-case pollutant concentrations and ensure that no violation of the National Ambient Air Quality Standards (NAAQS) will result.

Meteorological data are considered for the coldest day of winter as the meteorological conditions are conducive for air quality standard violations. Meteorological data includes wind speed, wind direction, standard deviation of wind direction, ambient temperature, humidity, mixing height, and atmospheric stability class. The iterative approach ensures that all wind directions are tested in the CALINE-Grid modeling regime. Meteorological data are obtained from a monitoring station that is nearest to the site.

The local aerodynamic roughness coefficient determines the amount of local turbulence that affects plume spreading. CALINE4 suggests various values for this coefficient to account for local turbulence. A standard value of 100 is used for the roughness coefficient for Atlanta area. However, this value could be changed by the user for different locations.

Ambient background pollutant concentrations also serve as a model input, since the modeling is seeking to determine the total effect that the roadway plus background will have on downwind concentrations. Users can input their own background concentrations or use the default value calculated for the Atlanta area. For the purposes of a default CO concentration in Atlanta, the closest CO measurements to the site were conducted during the Georgia Tech/USEPA Olympic Measurement program near the Olympic Natatorium on the Georgia Tech Campus preceding and following the Olympic games during the summer of 1996 (measurements during the Olympics were not analyzed as they were considered unrepresentative of normal conditions). These measurements give an average CO concentration of 1.27 ppmv (Grodzinsky, 1998; Pearson, J.R., 1999). For Atlanta, these data are scaled to the 1.6 ratio of

winter to summer CO concentrations recorded at the Tucker PAMS site to yield an estimated downtown background concentration of approximately 2.0 ppmv. Because regional traffic volumes and other sources of CO in the downtown have potentially increased since 1999, this value was increased to 3.0 ppmv to incorporate a margin of safety for background concentration estimates. In cases where predicted CO concentrations approach NAAQS concentration limits, the model development team recommends that site-specific background CO concentration field measurements be collected.

Receptor Geometry

A 50m x 50m grid is overlaid on top of the study area, and the nodes of this grid are designated as receptors for microscale modeling activities. The user can also enter specific receptor locations of interest (specific locations where human activity is expected to occur (FHWA, 1986)). The pollutant contribution of each link to these receptor locations are then estimated by CALINE-Grid, which runs the CALINE model in an iterative fashion. The impact of each roadway link on each receptor is modeled and then the impacts on each receptor from all links are summed. When users provide a link input table from a regional travel demand model, or even from a smaller corridor like the I-85 case study area, there are numerous links that do not have a significant impact on predicted receptor concentration. For example, links that are downwind of the receptor have zero impact on emissions. Low volume arterials located a great distance from a receptor will not significantly impact CO concentrations. Large numbers of unnecessary calculations slow down the processing speed of the tool. The Georgia Tech team has developed a screening tool that employs initial calculations of mass emissions from a link combined with wind speed and distance from link to receptor is used to identify those links that will not significantly contribute to downwind concentrations at a specific receptor (Shafi, 2008). This screening procedure will be added to the modeling system in the next system program upgrade. The Shafi (2008) screening tool described in the following section will be used to identify and remove from the analysis those link-receptor pairs for which the dispersion calculations are not needed, thereby reducing processing time for the model.

Link Screening Criteria

The CALINE-Grid modeling tool calculates the expected concentration contribution of every modeled transportation link for every receptor in the network grid. The contribution of the link to the pollutant concentration at each receptor is a function of the mass flux from the roadway (traffic volume and emission rate), the distance from roadway to receptor, the wind speed, and the orientation of the roadway relative to wind direction. Links that contribute very little emissions, either because traffic volumes are very low or because the links are located a significant distance from the receptor site, do not need to be included in the calculation process. The contribution of these links toward predicted concentrations is negligible and is already handled in the background concentration input value. Identifying the links that can be eliminated from the modeling process will significantly reduce model run times. In microscale

impact assessment, roadways that are located more than 1km from a receptor site rarely have an impact on predicted concentration. Hence, when very large networks are employed in microscale analysis, the vast majority of included links will have no impact on predicted concentrations and the screening tool really helps to reduce process time.

The goal of the link screening is to establish a set of objective rules that can be used to classify links as either significant or insignificant with respect to providing a concentration impact on a particular receptor. With such rules in hand, insignificant links can be removed from the analysis prior to conducting dispersion modeling, which significantly reduces computer modeling time. One basic research element undertaken in parallel with model development was the derivation of screening rules that could be used to eliminate links from the analysis. For the purpose of this study, any link whose contribution under the worst-case scenario to that receptor is less than 0.1 ppm was deemed to be insignificant (smaller values could be employed, but this is the smallest value currently output by CALINE4).

Hierarchical tree-based regression modeling is a widely used tool in data mining and is typically used in the construction of “decision trees.” In this case, the decision that would be made is whether or not to include a link in the emissions analysis. The tree-structured classification plan consists of set of attributes which are used to assign class membership to the links. Once developed, the tree based classification rules can be validated through the assessment of “dropping” in which cases from a new independent dataset are dropped through the tree and the results observed. Testing of tree on a new dataset helps to ensure the validity of the model tree.

To develop the classification tree, a data matrix known as a learning sample is needed. This learning sample contains observations consisting of a categorical outcome or response variable. The sample also contains a set of predictor, or independent variables. The learning dataset is developed by running CALINE4 to generate observations on 6 predictors: link length (m), linear hourly emissions (g/hr/mi), wind speed (m/s), wind directional variability (sigma theta), and receptor polar coordinates (m & theta). In developing the learning data set, the link is oriented in North-South direction and the center of the link is treated as origin. The symmetry of the problem allows the receptor (location of predicted concentrations) to be positioned only in the 1st (NE) coordinate. CO concentration (ppm) is the numeric dependent variable which is converted to a categorical value of significant or insignificant class as outlined earlier (i.e. for $C < 0.1$ ppm link is classified insignificant and significant otherwise). Other input parameters to the CALINE4 which were kept constant are: run type = standard, roughness coefficient = suburban, link type = at grade, mixing zone = 30 m, stability Class = 7, mixing height = 1000 m, and ambient temperature = 25°C.

There are a number of classification tree programs available to predict categorical outcome. QUEST (Quick, Unbiased, Efficient Statistical Trees) is a binary split tree-structured classification algorithm, developed by Loh and Shih (1997-2005), which has the following attributes:

- Employs univariate split, although an option of linear combination split is also available
- Uses an unbiased variable selection technique, which is important because some classification trees such as C&RT (Breiman, et al., 1984) that employ an exhaustive search for variable selection have a bias toward selecting variables offering more levels of split and can affect the predictive accuracy in the independent samples (Quinlan and Cameron-Jones 1995)
- Includes a family of splitting criteria
- Allows to prune on V-fold cross validation

QUEST involves use of fairly technical algorithms. However, unlike exhaustive search, it does not combine the problem of variable selection and split point selection. QUEST uses a statistical test of significance for the relationship of class membership, with each predictor using a suggested, or user-specified alpha value. Once a variable is selected, QUEST employs a modification of recursive quadratic discriminant analysis to determine the best split point. Complete details of the methodology can be found in Loh and Shih (1997).

The first component of the classification problem is developing the learning sample, which consists of 1800 modeled pollutant concentration outputs based upon iterations of the predictor variables. The decision cost matrix is a component of tree building by which unequal costs or penalties can be assigned for misclassification of classes. In our case, we deem it to be more serious to misclassify a significant (S) link as insignificant (IS), therefore costs are assigned as: $\text{Cost (IS|S)} = 2$, $\text{Cost (S|IS)} = 1$, where $\text{cost}(ij) = \text{cost of misclassifying class } j \text{ as class } i$.

Figure 7 shows the classification tree using QUEST options for discriminant-based univariate split and exhaustive search settings for split point selection with Gini Index, 10 fold CV pruning, and 1-SE rule. The value beneath each terminal node is the predicted class node with S and IS representing the number of significant and insignificant values respectively. Numbers beside each terminal node give the number of learning samples for each class in each node; IS to the left and S to the right. The splitting rule is given beside each intermediate node. The variables L, q, u, s.theta, R and phi represent link length, linear emissions, wind speed, wind directional variability, receptor distance and angle respectively. A maximal tree is built after which it is pruned back by V-fold cross validation. The best tree is selected using the SE rule. The values of V and SE can be user-specified or use the recommended defaults of 10-fold and 1-SE. The final tree consists of 35 terminal nodes; each corresponds to a classification rule in the form of an if-then statement. Thus, a set of 35 rules have been obtained on which future dataset can be tested.

The validity of the tree is analyzed through the classification rate, both for learning and future data. Classification matrices for the learning and future dataset are shown in Table 2 and depicted in Figure 8. Solid colors represent correct classification while patterns represent misclassification. Overall misclassification rates for learning and future dataset are 11.8% and 18.3%, while the rate of misclassifying a significant link as insignificant is 4% and 9% respectively.

Figure 7: Pie Charts Representing the Classification and Misclassification of Data

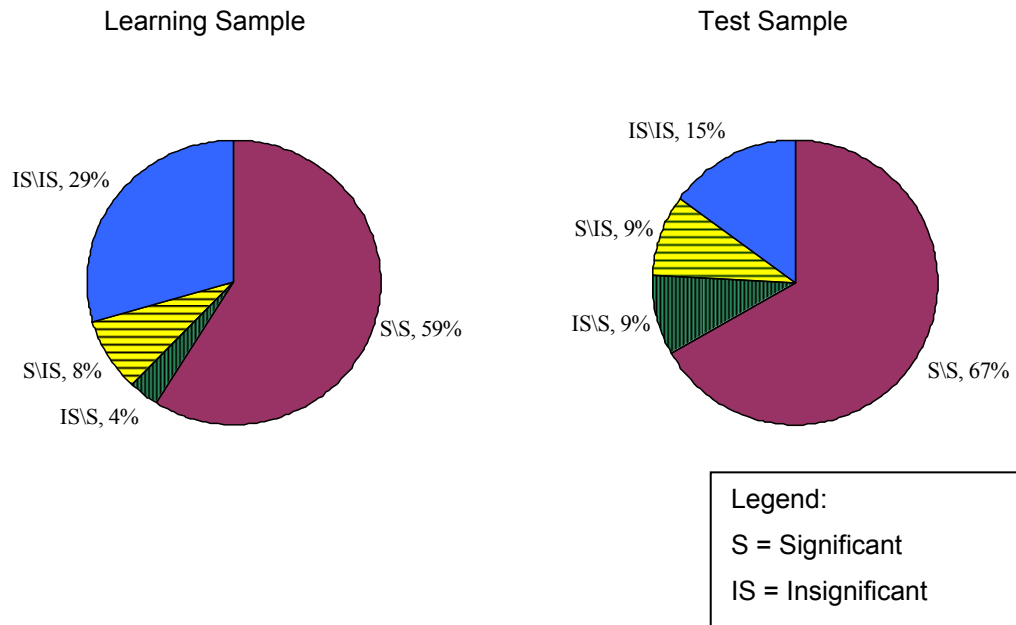


Table 2: Classification matrices for above cases

Learning sample			Test sample		
Actual Class	Predicted Class		Actual Class	Predicted Class	
	IS	S		IS	S
IS	529 (29%)	149 (8%)	IS	18 (15%)	11 (9%)
S	64 (4%)	1048 (59%)	S	11 (9%)	80 (67%)

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Classification trees are powerful tools for analyzing environmental data. Tree analysis can uncover complex relationships by assigning class memberships to data so that characteristics are known beforehand. Unlike traditional statistical techniques, interpretation of classification trees is easy. At the upper levels, variables are more significant so initial splits are made on those. Further down the tree, the significance of variables decreases. In summary, optimal trees can be used to establish screening criteria that help save substantial amounts of computational time and resources for problems such as this.

MOBILE Emission Rates used in CALINE

Composite emission rates developed in the MOBILE-Matrix element for each link are used as inputs to the CALINE model. It should be noted that travel demand models employ straight lines to represent links in the transportation system. A link length parameter is then associated with each link to represent the actual length of each segment. Using this information is especially important for curved roadways where the roadway length may be 20% greater than the straight line length, and where mass emissions on a per-mile basis are proportionally higher. To account for the additional roadway length, emission rates for each link are scaled-up by the ratio of actual segment length to the coded shape length of a link. This ensures that the proper mass emissions per hour from the segment are employed.

Prediction of Worst-Case Pollutant Concentration

Worst-case meteorological conditions are used for the analyses to predict the worst-case CO, PM_{2.5}, and PM₁₀ concentrations. This ensures that potential violations of ambient air quality standards can be identified and also provides a safety factor for the residing populations in the nearby areas. Once the input data are obtained, one set of program code is used to run the CALINE4 and another set of code processes the output to report the worst-case predicted CO, PM_{2.5}, and PM₁₀ concentrations.

Comparison of Predicted Concentrations with NAAQS

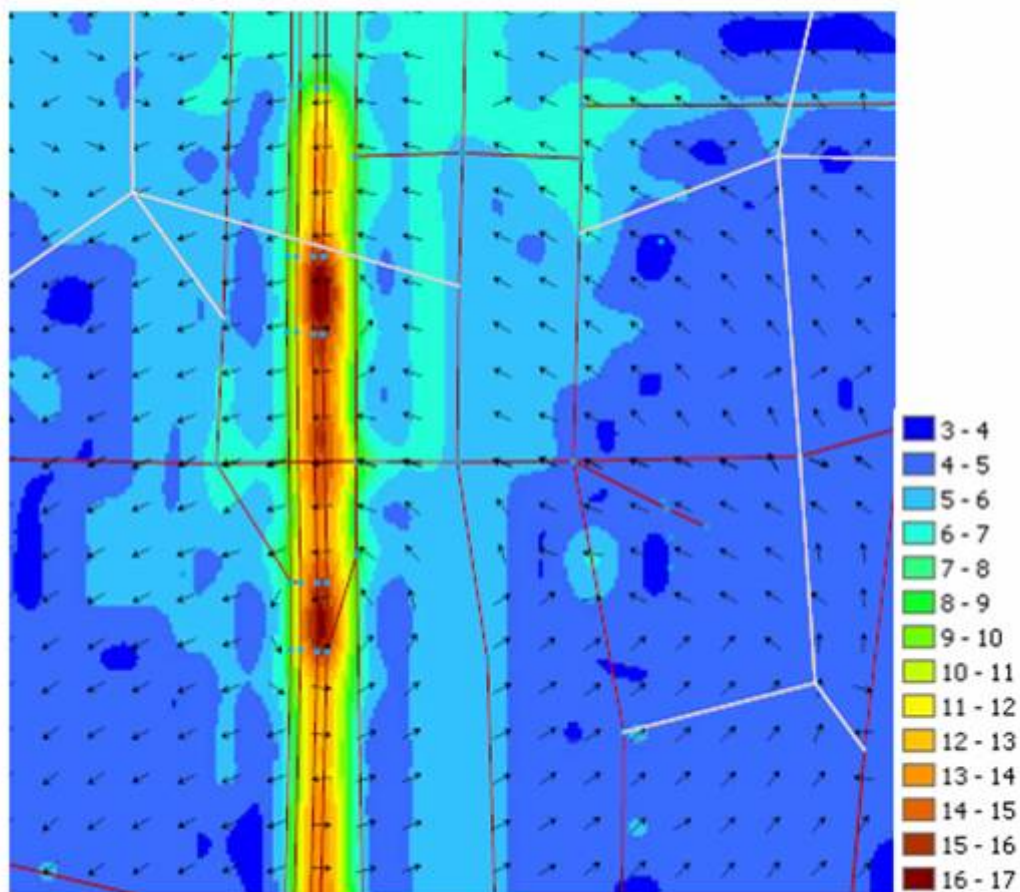
Pollutant concentrations are generally expressed in the units of parts per million over an averaging time. For CO concentrations, the NAAQS specify a standard of 9 parts per million over an 8-hour period and 35 parts per million over a 1 hour period. For PM_{2.5}, the standards are expressed as an annual mean² of 15 µg/m³ and a 24-hour mean of 35 µg/m³. For PM₁₀, the standard is 150 µg/m³ over a 24-hour averaging time. Any exceedence of these standards is considered to be harmful to public health and the environment. If the worst-case pollutant concentrations predicted from the model do not violate the national air quality standards, then the transportation project is not expected to violate the air quality standards under typical operating conditions. The modeling tool can be run for one-hour scenarios and results can be aggregated for multi-hour demonstrations.

² Annual mean compliance is modeled and demonstrated at the regional level rather than the microscale level.

Graphical Presentation of Results on the Receptor Grid

The CALINE4 outputs provide CO, PM_{2.5}, and PM₁₀ concentrations for any given wind angle, or can provide worst-case predicted concentrations and identify the worst-case wind angle for each receptor. These output data are then used for the development of standardized figures to help decision makers visualize the net impacts of the transportation system on predicted pollutant concentrations. Figure 9 presents an example carbon monoxide isopleth chart illustrating the worst-case CO concentrations (ppm) at each receptor in the receptor grid overlying the I-85 study area. The vectors in the figure are indicators of direction of the worst-case wind angle at each receptor site. The modeling tool also provides the flexibility of adding specific receptors of interest to the modeling runs so that they can be highlighted in EIS and conformity analyses. This allows special receptors of interest in environmental impact assessment analyses, such as locations where human activity is expected to occur (FHWA, 1986), to be designated with additional receptors that fall inside of the 50m grid so that concentrations can be included in EIS documentation.

Figure 9: Isopleth Figure of Worst-Case One-Hour CO Concentrations (ppm) and Worst-Case Wind Angles for each Receptor on the Study Area Grid



MOBILE-Matrix and CALINE-Grid User Interface

A Graphical User Interface (GUI) allows users to conveniently interact with the MOBILE- Matrix/CALINE- Grid modeling tool. Figure 10(a) and 10(b) display a flowchart that describes the process of using the GUI. Users must first decide whether they wish to perform a mass emissions analysis (following the steps in Figure 10(a)) or a pollutant dispersion analysis (following the steps in Figure 10(b)). Then users must decide whether they want to rely upon the default data for various vehicle fleet, vehicle activity and meteorological input parameters, or whether they will provide a series of input file containing more representative input data. Users must define the roadway characteristics and operating parameters for each roadway link they plan to include in the analysis. Input data include link from and to coordinates, facility type, average speed, temperature, calendar year, evaluation month, traffic volumes etc. Some of these parameters are used to pull the gram/mile base emission rate sub-matrix from the multi-dimensional look up matrix.

Vehicle fleet characteristics can be input directly or derived from national defaults. The previously selected base emission rate sub-matrix is weighted by the class composition fractions and processed to yield composite fleet average gram/mile emission rates for each link.

Mass Emissions

Mass emissions coming from the roadway are used to develop emissions inventory for transportation conformity purposes and State Implementation Plans. The composite emission rate is developed through the MOBILE-Matrix procedure as described earlier. VMT is calculated for each link by multiplying link length by the daily, monthly, or annual traffic volumes on that link. The mass emissions contribution of each link is then calculated by multiplying the VMT by the composite fleet average emissions rate for that link. The mass emissions contribution from all the links in the selected area is summed up to yield the total mass emissions per hour, day, or year.

$VMT = (\text{Traffic volume} \times \text{Roadway length})$

$$\text{Mass emissions} = \sum_{i=1}^n (\text{Fleet average emissions rate} \times VMT)$$

Where:

VMT is vehicle miles of travel

n is the number of roadway links

The calculated mass emissions for each link are displayed on the roadway network using color codes to help policy makers to compare various policy options. Figure 11 displays such a chart that displays mass emissions per day for each link for a small stretch of I-85.

Figure 10 (a): Flowchart Describing the Interface Procedure to Estimate Mass Emissions

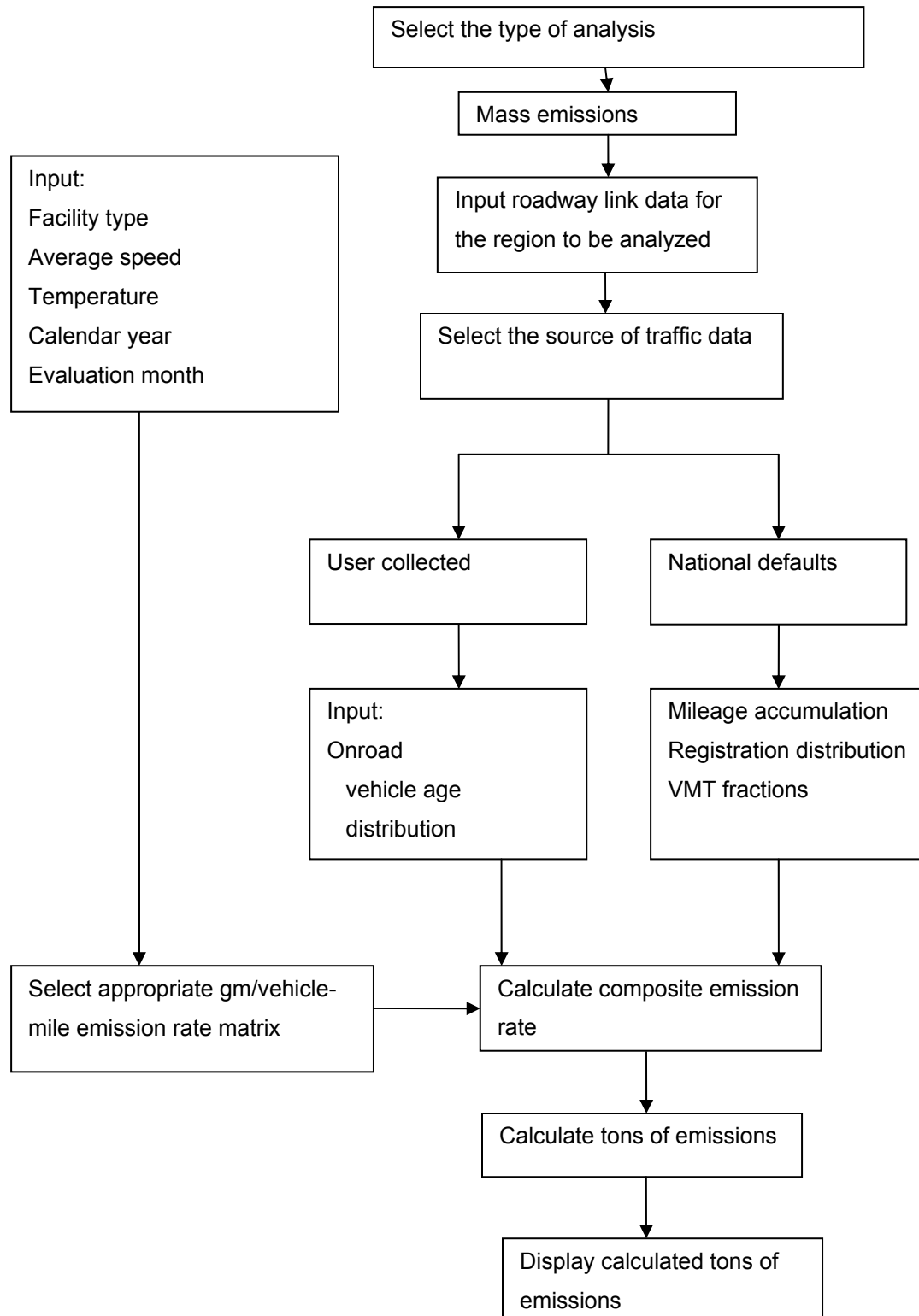


Figure 10 (b): Flowchart Describing the Interface Procedure for Pollutant Dispersion

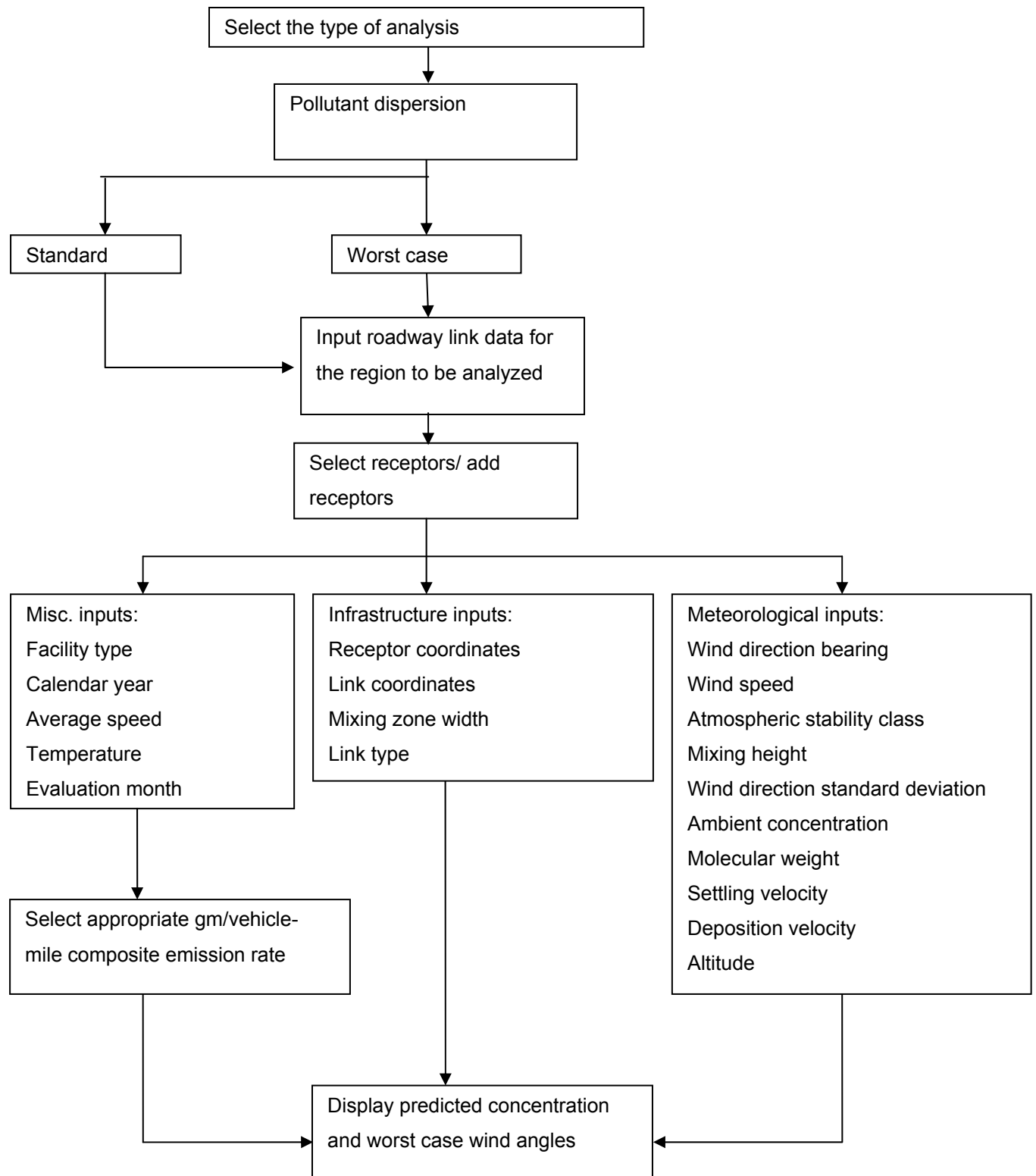


Figure 11: Link-Specific Mass Emissions per Day for a Segment of I-85 in Atlanta



Pollutant dispersion

In case of selection of pollutant dispersion option, a procedure similar to the one performed for mass emissions analysis is followed by developing link-specific composite emission rates. In addition to the link input data, receptor spatial data can be provided by the user. Various infrastructure and meteorological inputs are provided in addition to the traffic inputs. These inputs are required to run the CALINE-Grid component of the tool to predict downwind CO, PM_{2.5}, and PM₁₀ concentrations at selected receptor locations. Users can select the type of run they want to perform from either standard or worst-case run options. For a standard run, the CALINE-Grid predicts pollutant concentrations for a chosen wind angle, while the worst-case option finds the combination of wind angles that produce the highest pollutant concentrations. After the pollutant concentrations have been predicted they are displayed on an isopleth chart.

Visual Basic Interface

A visual basic user interface has been developed for the modeling tool to assist users with data entry and model operations. Figure 12 provides screen-shots of the various screens in the MOBILE-Matrix / CALINE-Grid tool user interface.

Figure 12a: Analysis Type Selection

User-Interface Screens for the MOBILE-Matrix/CALINE-Grid Tool

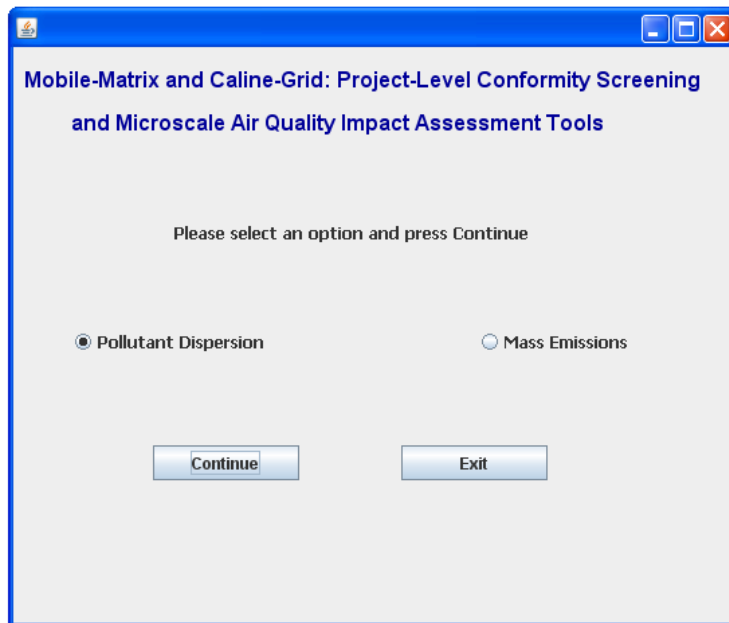


Figure 12b: Pollutant Dispersion Analysis Type Selection

User-Interface Screens for the MOBILE-Matrix/CALINE-Grid Tool

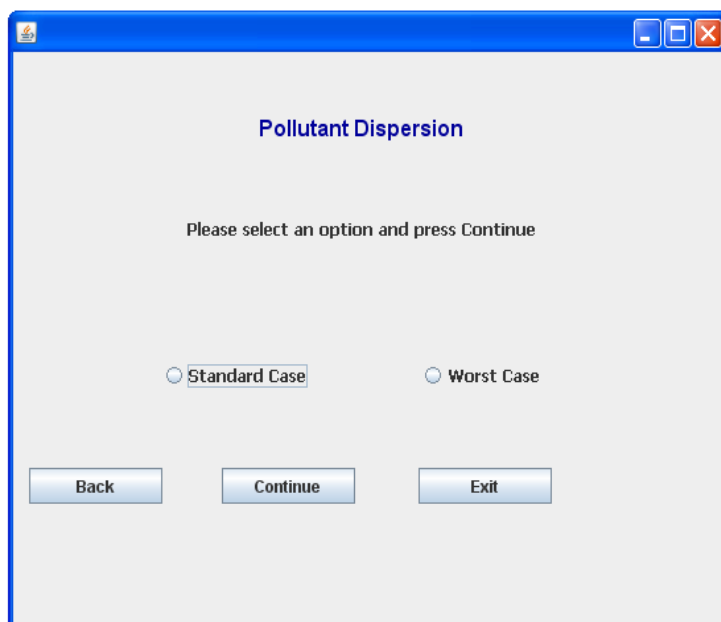
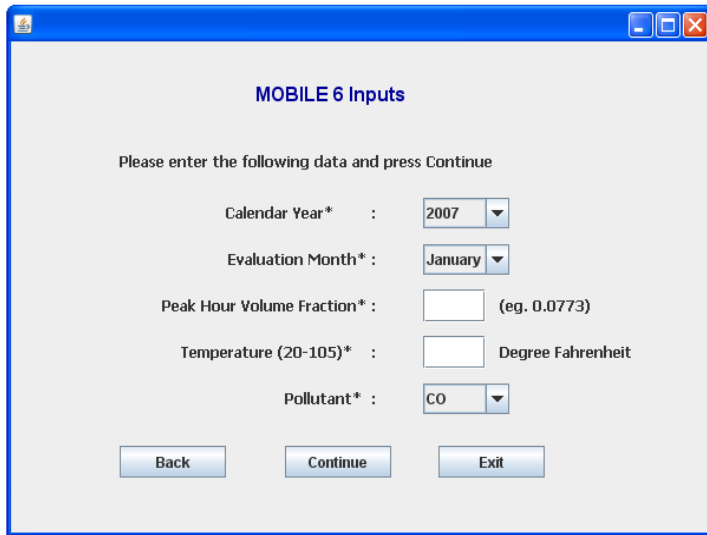


Figure 12c: MOBILE 6 Inputs

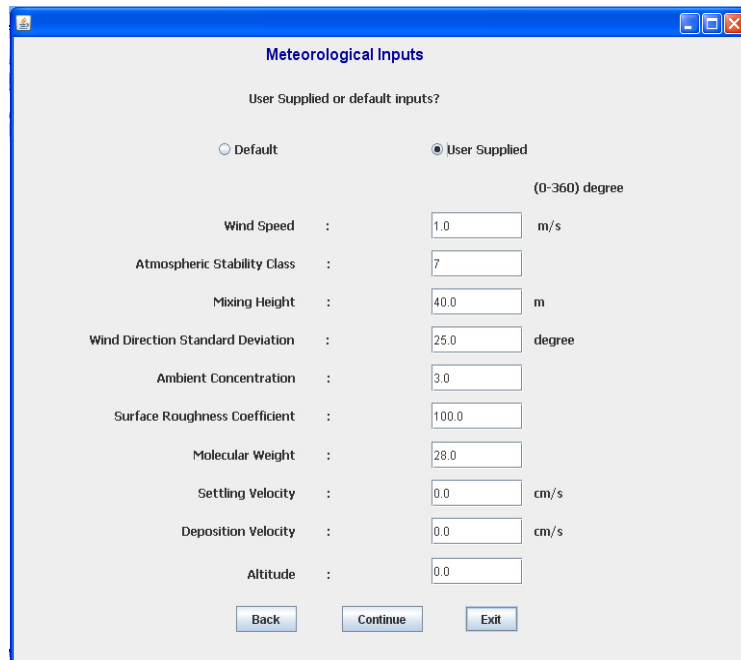
User-Interface Screens for the MOBILE-Matrix/CALINE-Grid Tool



A screenshot of a Windows-style dialog box titled "MOBILE 6 Inputs". The dialog has a blue title bar with standard minimize, maximize, and close buttons. The main area is light gray and contains the text "Please enter the following data and press Continue". Below this text are five input fields, each with a label and a colon: "Calendar Year*" with a dropdown menu showing "2007"; "Evaluation Month*" with a dropdown menu showing "January"; "Peak Hour Volume Fraction*" with a text box and a hint "(eg. 0.0773)"; "Temperature (20-105)*" with a text box and a hint "Degree Fahrenheit"; and "Pollutant*" with a dropdown menu showing "CO". At the bottom of the dialog are three buttons: "Back", "Continue", and "Exit".

Figure 12d: Meteorological Inputs

User-Interface Screens for the MOBILE-Matrix/CALINE-Grid Tool



A screenshot of a Windows-style dialog box titled "Meteorological Inputs". The dialog has a blue title bar with standard minimize, maximize, and close buttons. The main area is light gray and contains the text "User Supplied or default inputs?". Below this text are two radio buttons: "Default" and "User Supplied", with "User Supplied" being selected. To the right of the "User Supplied" radio button is the text "(0-360) degree". Below the radio buttons are ten input fields, each with a label and a colon: "Wind Speed" with a text box showing "1.0" and a unit "m/s"; "Atmospheric Stability Class" with a text box showing "7"; "Mixing Height" with a text box showing "40.0" and a unit "m"; "Wind Direction Standard Deviation" with a text box showing "25.0" and a unit "degree"; "Ambient Concentration" with a text box showing "3.0"; "Surface Roughness Coefficient" with a text box showing "100.0"; "Molecular Weight" with a text box showing "28.0"; "Settling Velocity" with a text box showing "0.0" and a unit "cm/s"; "Deposition Velocity" with a text box showing "0.0" and a unit "cm/s"; and "Altitude" with a text box showing "0.0". At the bottom of the dialog are three buttons: "Back", "Continue", and "Exit".

Figure 12e: Input Tables

User-Interface Screens for the MOBILE-Matrix/CALINE-Grid Tool

The screenshot shows a Windows-style dialog box titled "Input Tables". Inside the dialog, there is a message "Please provide input tables and press Continue". Below this message are two radio buttons: "Default" (which is unselected) and "User Supplied" (which is selected). Under the radio buttons, there are three input fields, each followed by a "Browse" button. The input fields are labeled "Links File :", "Receptors File :", and "On Road Vehicle age distribution :". At the bottom of the dialog, there are three buttons: "Back", "Submit", and "Exit".

Input Data

The traffic and meteorological parameters are the factors that affect predicted emissions from a roadway. Table 3 below shows the function of various input parameters for MOBILE-Matrix/CALINE-Grid tool, format of input, and whether the input is user-supplied or default. The traffic parameters include traffic volumes, mileage accumulation, registration distribution, VMT fractions and average speed. The meteorological parameters include temperature. The MOBILE-Matrix/CALINE-Grid tool provides a unique framework to study the effects of all these parameters on roadway emissions.

Table 3: Function of Various Input Parameters, Variable Formats and Source of Input Data for MOBILE-Matrix/CALINE-Grid

Input Parameter	Variable Format	Input Type	Description
MOBILE-Matrix			
Average speed	Real	User-supplied	Used to look up appropriate gram/mile emission rate.
Temperature	Real	User-supplied	Used to look up appropriate gram/mile emission rate. An input to CALINE-Grid
Calendar year	Integer	User-supplied	Used to look up appropriate gram/mile emission rate.
Evaluation month	Integer	User-supplied	Used to look up appropriate gram/mile emission rate.

Input Parameter	Variable Format	Input Type	Description
Traffic volumes	Integer	User-supplied / Default	Used to calculate Vehicle Miles of Travel (VMT) to develop emissions inventory Used as an input to CALINE-Grid Default traffic volumes are used from the ARC TP+ network in absence of user-supplied volumes.
Mileage accumulation	Real	User-supplied / Default	Used to weight the base emission rate from MOBILE6 to incorporate mileage accumulation effects. National default mileage accumulation rates are used in the absence of user-supplied data.
Registration distribution	Real	User-supplied / Default	Used to weight the base emission rate from MOBILE6 to incorporate the contribution of model years. ARC default registration distribution fractions are used in the absence of user-supplied data. These were developed by Georgia EPD from Polk data, but used by both agencies.
VMT fractions	Real	User-supplied / Default	Used to weight the emission rate from MOBILE6 weighted by mileage accumulation and registration distribution and aggregated by model years, to incorporate the contribution of vehicle classes. Default National VMT fractions are used in the absence of user-supplied data.

Input Parameter	Variable Format	Input Type	Description
Onroad vehicle age distribution	Real	User-supplied	These fractions represent the observed onroad vehicle fleet characteristics and are used to incorporate the contribution of all the model years and vehicle classes. Users can develop these fractions using the data collected during a field study which could be used to replace the mileage accumulation and registration distribution fractions. Mileage accumulation and registration distribution fractions are used as defaults in the absence of user-supplied on road vehicle age distributions.

Input Parameter	Variable Format	Input Type	Description
CALINE-Grid			
Pollutant Type	Integer	User-supplied	Allows the user to select the pollutant (CO, PM _{2.5} , or PM ₁₀) for estimation of downwind concentrations.
Surface roughness coefficient	Real	User-supplied / Default	Influences the amount of ground level turbulence (and mixing) due to physical features. A default value of 100 is set, which can be replaced by a user-supplied value.
Settling velocity	Integer	User-supplied / Default	Determines the rate of settling of particles.
Deposition velocity	Integer	User-supplied / Default	Determines the rate of deposition of particles.
Receptor name	String	Default / User-supplied	Allows users to specify receptor names. A default receptor ID is provided in the absence of a user input.
Receptor coordinates	Real	User-supplied / Default	Users can select or add a new receptor for analysis using a pointer.
Link name	String	User-supplied / Default	Allows users to specify link names. A default link ID is provided in the absence of a user input.

Input Parameter	Variable Format	Input Type	Description
Link coordinates	Real	User-supplied / Default	Users can select or add a new link for analysis using a pointer.
Link height	Real	User-supplied	Allows the user to specify height for any link that is above grade. All the links are assumed to be at grade by default.
Mixing zone width	Real	User-supplied / Default	Allows the user to specify the width of mixing zone in case of a new roadway. It is calculated as the sum of the roadway width and 3 meters zone on each side of the roadway.
Run type	Integer	User-supplied	Allows the user to select the type of analysis from the following alternatives: Worst-case analysis Standard run
Wind direction bearing	Real	User-supplied	Allows user to input the most recent wind direction data.
Wind speed	Real	User-supplied	Allows user to input the wind speed.
Atmospheric stability class	Integer	User-supplied / Default	Allows the user to specify a value from 1 through 7. It's a measure of turbulence in the atmosphere. Stability class 7 represents most stable conditions.
Mixing height	Real	User-supplied / Default	Allows the user to input the altitude to which thermal turbulence occurs.
Wind direction standard deviation	Real	User-supplied / Default	Allows the user to input the standard deviation of wind direction in case of standard option.
Ambient concentration	Real	User-supplied / Default	Allows users to input pre-existing background level of pollutants, expressed in parts per million. A default value of 3ppm is assumed.

Conclusions and Future Work

Analyzing the impacts of potential transportation projects on air quality is a complex process that involves execution of multiple procedures, making the comparison of project alternatives for conformity and environmental impact assessment purposes difficult. The State of Georgia currently employs federally-approved analytical procedures for the assessment of project-level air quality impacts. However, the new MOBILE-Matrix modeling tool developed as part of this research effort allows users to move beyond current Federal agency guidance on qualitative PM_{2.5} analyses in anticipation of changes that will be forthcoming from federal agencies over the next 24 months. Emission rates and vehicle activities linkages occur at the link-level, facilitating direct adaptation of the new system to the forthcoming MOVES emission rate model, which will significantly change the way that mass emissions are calculated on a link-by-link basis. The modeling tool reported herein also allows agencies to more readily assess the impacts of transportation policies with non-traditional impacts on such factors as onroad model year and vehicle class distributions. For example, when a pricing policy such as the implementation of high-occupancy toll lanes yields a combined effect on traffic volumes, vehicle speed and acceleration profiles, and subfleet composition (with a shift toward newer vehicles using the toll lanes), the current modeling systems require that the EPA MOBILE emission rate model be re-run many times to generate appropriate emission rates for each scenario. The MOBILE-Matrix module allows users to run a single analysis for such projects by pre-processing emission rates and automating the process of linking subfleet activity to appropriate emission rates.

The MOBILE-Matrix and CALINE-Grid modeling tool provide a single system that automates the majority of these procedures. The modeling tool supports the estimation of subfleet-specific emission rates for each transportation link, estimation of hourly mass emissions by link, and downwind microscale impact assessment for a large number of receptors. The model provides for simultaneous assessment of the impacts of all modeled transportation links on all receptors, including special receptors of interest. The modeling tool presents the results of the analyses in a graphical output that enhances the visualization and interpretation of the results and aids in the decision making process. The tool described in this report can be used for comparative analyses across project or policy alternatives. Users can adapt the model to their specific regional conditions, without having to rely on the MOBILE6.2 default values. The ability to use an observed local subfleet composition is especially useful since the use of MOBILE6.2 default values for registration mix and mileage accumulation will yield significantly different onroad subfleet and consequently the emissions predictions that are different from the real world emissions. The report demonstrates the application of the tool for a small region in Atlanta. However, the processes are designed to be scalable so that it could easily be expanded to cover an entire metropolitan region.

There are a number of model improvements that have been proposed by the model development team for incorporation into the next model version:

- A new procedure would distribute single-point average speed estimates (e.g. based upon simulation model or travel demand model outputs) across the 14 speed bins to enhance emission rate prediction accuracy
- Correction factors for mileage accrual effects need to be integrated to account for the deterioration effects of greater mileage accumulation on the vehicle emissions
- Model code should be added to implement the new screening tool used to identify transportation links whose contributions are insignificant to the receptors in the CALINE-Grid component need (integration of the new code will eliminate more than 70% of the links from consideration and significantly increase processing speed)
- Sensitivity analysis should be performed to determine the parameters which most significantly affect the particulate matter emission rates and these results will guide additional model improvement efforts for particulate attainment planning

Transportation and Land Use Models

Overview of Assessment Methods

Land use models are the tools that can be used to measure the land use impacts of transportation improvements. Many states have published guidebooks presenting such models and their approach and methods. However, they tend to provide a limited source of methodologies partly because of budget and time constraints. For example, Maryland discourages the use of more advanced quantitative methods, favoring qualitative and simple quantitative methods. Oregon provides a single forecasting methodology (Avin et al., 2007).

The impacts of transportation projects on land use can be measured by several approaches. The first is to ask people how they will change their behavior if transportation system changes are made (“stated preferences”). The second is to draw conclusions from empirical results (“revealed preferences”). The third approach is mathematical methodologies by which the impacts are simulated (Hensher et al., 2004).

Integrated land use and transportation models fall within the third approach. Other tools include qualitative methods, allocation rules, statistical methods, GIS (Geographic Information System), and regional economic models.

Qualitative methods, such as Delphi, are used to measure an interaction between transportation and land use, conducting surveys with experts. Allocation rules, such as simple gravity models, are used to

estimate how growth would shift due to changing travel behaviors from improved transportation systems. Statistical methods include multiple linear regression, estimating capitalized property values resulting from the improved accessibility (“ease in reaching desired activities”) from the infrastructure investment, and discrete choice (or multinomial logit) models, measuring individual choices of locations (residential or businesses) after changes in transportation systems. Discrete choice models require substantial surveys at an individual level. GIS has been increasingly used in impact assessment of transportation planning. However, GIS method is known to be useful when used with other tools, such as land use models or regional economic models rather than used as a sole method or tool. Regional economic models, using input-output models, econometric models, and combinations of the two, estimate population and economic growth, and are used to make land use estimates (Parsons Brinckerhoff Quade & Douglas, Inc., 1998).

Integrated Land Use and Transportation Models

This section, based on these references³, describes several land use models that have been used to estimate how the accessibility from changes in the transportation system affects location of population and employment and how accessibility is affected by changed congestion from relocated population and employment (The Louis Berger Group, Inc., 2002). Table 4 presents the summary of these models followed by an overview of each model.

Table 4 - Summary of Transportation Land Use Models

Name	Policies	Data	Spatial Unit
DRAM/EMPAL	<ul style="list-style-type: none"> • land use regulations • transportation improvements 	<ul style="list-style-type: none"> • employment • households • land area by use and total land area • developable land (vacant) • travel cost matrix 	<ul style="list-style-type: none"> • TAZs or higher
MEPLAN	<ul style="list-style-type: none"> • land use regulations • transportation improvements • transportation cost changes 	<ul style="list-style-type: none"> • employment • land use and its price • floor space and its price • input-output tables • forecast of basic employment • transportation network 	<ul style="list-style-type: none"> • Groupings of TAZs

³ Hensher, D.A., K.E. Haynes, & P. Stopher. (2004). *Handbook of Transport Geography and Spatial Systems*. Emerald Group Publishing; Parsons Brinckerhoff Quade & Douglas, Inc. (1998). *Land Use Impacts of Transportation: A Guidebook*. The National Cooperative Highway Research Program (NCHRP) Project 8-32(3); The Louis Berger Group, Inc. (2002). *Desk Reference for Estimating the Indirect Effects of Proposed Transportation Projects*. The National Cooperative Highway Research Program (NCHRP) Report 466.

Name	Policies	Data	Spatial Unit
METROSIM	<ul style="list-style-type: none"> • Transportation improvements 	<ul style="list-style-type: none"> • Census Transportation Planning Package(CTTP) • transportation network 	<ul style="list-style-type: none"> • TAZs or higher
UrbanSim	<ul style="list-style-type: none"> • land use regulations • transportation improvements 	<ul style="list-style-type: none"> • regional control totals for population and employment • households • land use by parcel • land use and government regulations • infrastructure plans • environmental constraints • development costs • travel cost matrix 	<ul style="list-style-type: none"> • TAZs or higher

Source: The Louis Berger Group, Inc. (2002).

DRAM/EMPAL

DRAM/EMPAL, developed by Stephen H. Putman in the 1970s, includes three components: the Disaggregated Residential Allocation Model (DRAM), the Employment Allocation Model (EMPAL), and travel demand models. The model is based on the Lowry-gravity model method. While this method is widely used in many agencies, including Kansas City, Seattle, Dallas-Fort Worth, Detroit, Houston, Los Angeles, Phoenix, and San Diego Metropolitan Planning Organizations (MPOs), and the Florida DOT, it demands a large set of data and a long time period to conduct the analysis (The Louis Berger Group, Inc., 2002; Parsons Brinckerhoff Quade & Douglas, Inc., 1998).

Several input data, including employment, households by income quartile, vacant developable land, residential land, and a zonal travel matrix are used in DRAM, and lagged employment data, total land area, total lagged households, and a zonal travel matrix in EMPAL. Once the number of households and employments are predicted by DRAM and EMPAL, respectively, they are translated into residential, basic, and commercial lands, using another submodel, LANDCON.

The impacts of changes in transportation system, such as a roadway construction or transit system development, can be measured by inputting a revised zonal travel matrix from these changes and reallocating population and employment.

MEPLAN

MEPLAN, developed and refined by Marcial Eschenique and others since 1967, contains three submodels and an evaluation model. LUS estimates the demand for production inputs to specific zones,

FRED converts the demand into transportation flows of goods and people, and then TAS distributes the flows in the network. The evaluation model assesses the effects of transportation projects on land use and transportation. Although this method adopts the principle of Lowry-gravity model, it includes discrete choice analysis, input-output models, and random utility theory.

The model uses zonal level data, including land use and land prices, floorspace and prices, population, employment, input-output structure, exogenous forecast of basic employment, travel network, and policies.

In the model, industries and households are allocated to zones based on random utility theory where people act in a way of cost minimizing and profit maximizing. Since the model links supply and demand for land, floor space, and other production inputs, and calculates elasticities in demand with respect to their prices, it is known to be useful for evaluating a wide range of policies, such as parking charges, transit rates, and congestion pricing, because such policies change the price or supply of production inputs (The Louis Berger Group, Inc., 2002).

However, since MEPLAN uses an economic input-output modeling, which uses inter-regional data and is suitable to regional level analysis, the structure of the model may be better for intercity modeling than for intraurban modeling (The Louis Berger Group, Inc., 2002; Parsons Brinckerhoff Quade & Douglas, Inc., 1998).

METROSIM

METROSIM, developed by Alex Anas at the State University of New York at Buffalo, is also based on random utility and microeconomic theory for its theoretical foundation. Its earlier models were adapted for the Chicago area (CATLAS), the New York (NYSIM), Chicago, Houston, Pittsburgh, and San Diego MSAs (CPHMM) (Parsons Brinckerhoff Quade & Douglas, Inc., 1998). Instead of the Lowry gravity model, METROSIM, a discrete choice model of housing location, is based on an economic, market-based approach.

A simultaneous equations system is used for estimating land prices and achieving equilibrium in labor, housing, and commercial markets, using CTPP (Census Transportation Planning Package) data, transportation network by mode, and real estate data.

Similar to MEPLAN, METROSIM is applicable to a variety of policy analyses. However, while the data requirements are minimal and are easily obtainable, the analysis is very complex and substantial consultation is required.

UrbanSim

UrbanSim, recently developed by Paul Waddell, University of Washington in the late 1990s, is a software based system, incorporating interactions between land use, transportation, and public policy. The model is based on random utility theory and uses discrete choice models.

The input data include regional control totals for population and employment, existing land use at the parcel level, household characteristics, land use plans with GIS data, environmental constraints, development costs including development fees, and accessibility.

The decisions made by the public sector, including land use, population and employment, regional economic forecasts, public policies, such as transportation system plans, land use plans, and development impact fees, are exogenously modeled. The model endogenously estimates the decisions made by households, employers, and developers. These decisions may include the location of employment and population, the characteristics of new development and redevelopment, and the prices of land and buildings.

Calibration is performed using multiple regression for bid price functions, and logit estimation is used for predicting the choice of locations. UrbanSim integrates with a travel demand model, such as TRANPLAN, EMME/2, and MINUTP, where travel costs and congestion are recalculated.

While UrbanSim is capable of modeling government policy scenarios and compatible with travel demand models, substantial data at the parcel level are required. Yet, it represents an opportunity to assess the impact of congestion pricing policies.

Assessment of Congestion Pricing on Land Use

The planning functions that consider transportation planning and land use can be divided into three categories: base case land use forecast, impact assessment, and policy assessment. Base case forecasts provide a reference data for impact and policy assessments. Impact assessments consider how transportation projects, such as construction of transportation facilities, change of new highway interchange, or a transit center, affect land use. However, policy assessments are focused on the land use impacts of transportation policies, such as congestion pricing and parking pricing. Since transportation policies are not necessarily combined with physical construction of transportation facilities, the assessment should depend more on the travel behaviors of households, workers, and employers. This makes it difficult to capture the land use changes because predominant behaviors under such policies have not been well revealed.

Table 5 - Procedures of Assessment of Transportation Impacts on Land Use

Base case forecasts	Impact Assessment	Policy Assessment
1. Existing conditions and trends (GIS)	1. Existing conditions and trends (Survey, GIS)	1. Existing conditions and trends (Survey, GIS)
2. Establishing Policy assumptions (Survey, GIS, Statistical methods)	2. Policy assumptions (Survey, GIS, Statistical methods)	2. Policy assumptions (Survey, GIS, Statistical methods)
-	3. Transportation outcomes with and without project (Travel demand and freight models)	3. Transportation outcomes with and without the policy change (Travel demand and freight models)
3. Regional population and employment growth resulting from change in accessibility (Regional economic and demographic models)	4. Population and employment growth with and without project (Qualitative methods, regional economic and demographic models, land use models)	4. Total study area population and employment growth (Qualitative methods, regional economic and demographic models, land use models)
4. Inventory developable land (GIS)	5. Inventory developable land (GIS)	5. Inventory developable land (GIS)
5. Assign population and employment to specific locations (Delphi, Allocation rules, Statistical methods, Land use models)	6. Location and types of residential and business development within the study area (Delphi, Allocation rules, Statistical methods)	6. Location and types of residential and business development within the study area (Delphi, Allocation rules, Statistical methods)

Source: Reorganized from Parsons Brinckerhoff Quade & Douglas, Inc. (1998)

While the integrated transportation land use models can predict the transportation impacts on land uses specifically, MEPLAN is capable of incorporating changes in transportation cost into the model. A comprehensive framework of the policy assessment (Table 2) suggests that the assessment should include the pre-analysis steps, such as examining the trends in study areas and understanding travel behaviors, to make reasonable policy implications. In addition, other methodologies, such as qualitative methods, allocation rules, GIS, and statistical methods, should be used in different steps in combination with land use models.

As shown in Table 2, the basic steps in the assessment include identifying existing conditions and trends, establishing policy assumptions, identifying developable land, and assigning population and employment growth to specific areas. However, the impact assessment adds one more step where changes in accessibility and travel behaviors resulting from transportation projects are examined, and accordingly changes in land use patterns are measured.

The policy assessment, including congestion pricing assessment, has a similar procedure to impact assessment. However, it is difficult to determine how accessibility and travel behaviors of households, workers, and businesses will change. For example, the pricing increase will negatively affect lower income workers and businesses who may consider leaving the areas where prices become higher, while these areas would be attractive to businesses with higher income employees. Also, there could be diverse reactions to congestion pricing. Some people may not change their behaviors by simply paying the charges or may change their routes to avoid the charges. Other behaviors may include making more trips, reducing the number of trips, and changing the location where they live and shop. Without consensus on the results on these options, it is difficult to measure the land use impacts. Thus, the model should be sensitive to both travel behavior and land use (Hensher et al., 2004). Because the results may be different for each metropolitan area depending on socio-economic characteristics, existing traffic conditions, and other combined transportation policies, such as transit system subsidies, qualitative methods (*e.g.* Delphi, survey, interview, and case studies) could complement mathematical land use models.

Conclusions

Several integrated transportation and land use models have been used to measure the impacts of transportation projects or policies on land use changes. Most popular models, including DRAM/EMPAL, MEPLAN, METROSIM, and UrbanSim, have variations with respect to the policies modeled, the required data, theoretical foundations, and calibration.

While those models have been successfully implemented at a metropolitan or regional level, no currently operational models cover all aspects of an ideal model (Hensher et al., 2007). A comprehensive framework should be adapted to measure the impacts and produce useful implications, including a series of procedures from understanding the current conditions and trends to allocating estimated effects to specific areas. In addition, other complementary methods, such as qualitative methods, allocation rules, regional economic models, statistical methods, and GIS, should be incorporated into the methodology.

Specifically, unlike construction projects in transportation planning, congestion pricing involves complex measurements of travel demand and behavior to conduct the policy assessment. Qualitative methods, including Delphi, interview, survey, and case studies, in combination with other methods and land use models could be useful. In other words, similar to other decision making tools, land use models would be tools that can help researchers or decision makers understand the impacts within the assessment procedure rather than magical tool boxes that produce the results.

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